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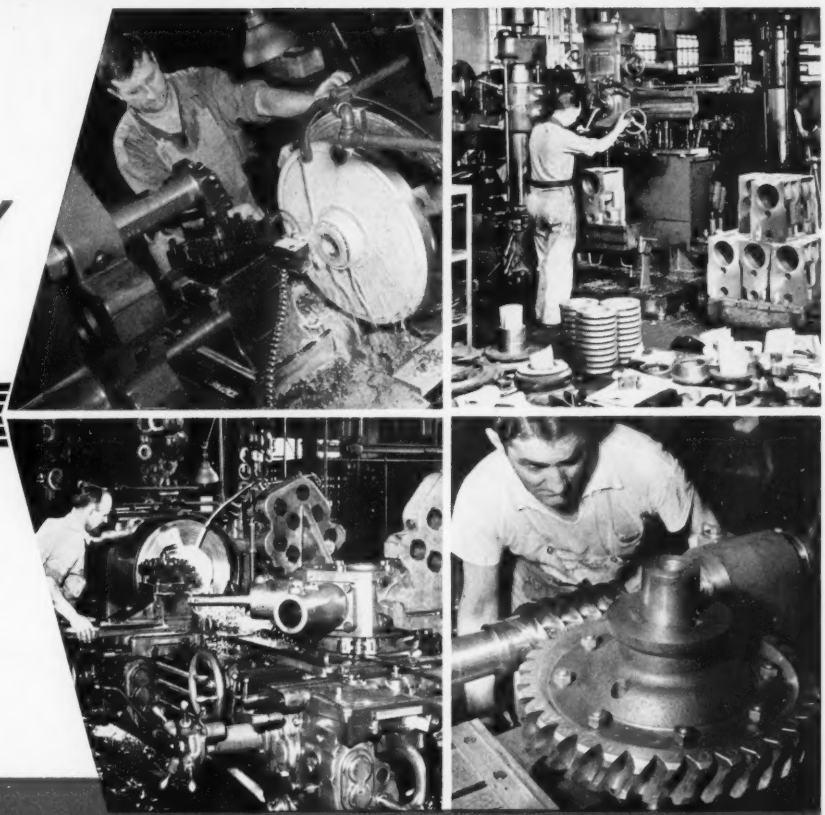

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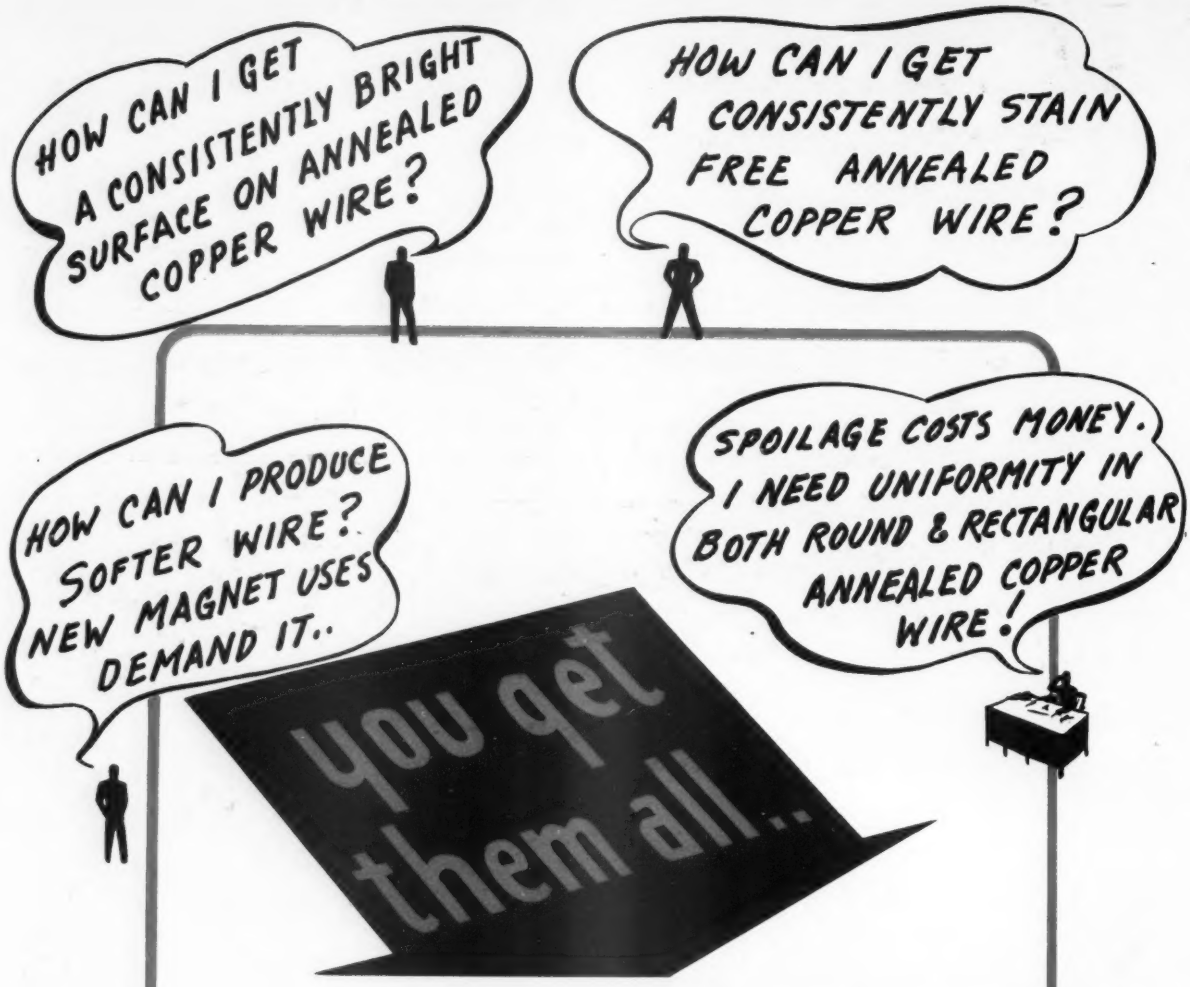
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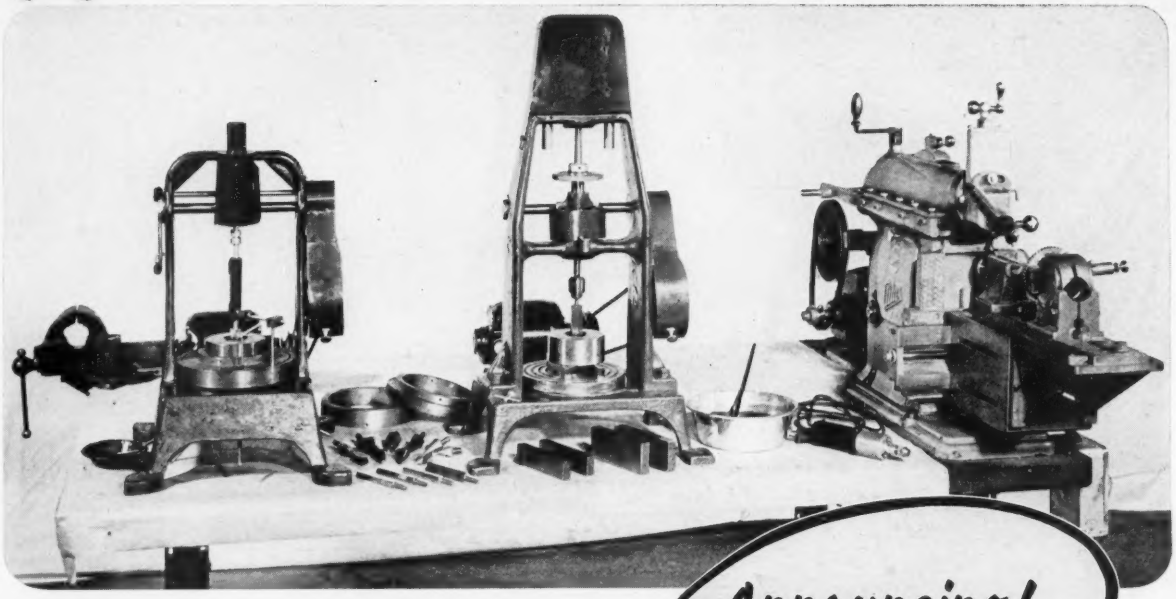

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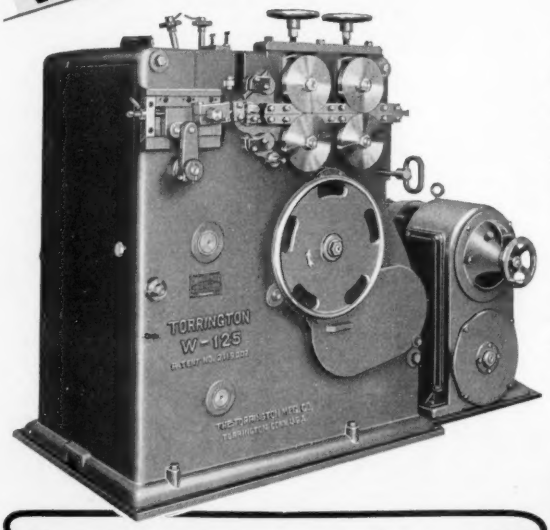

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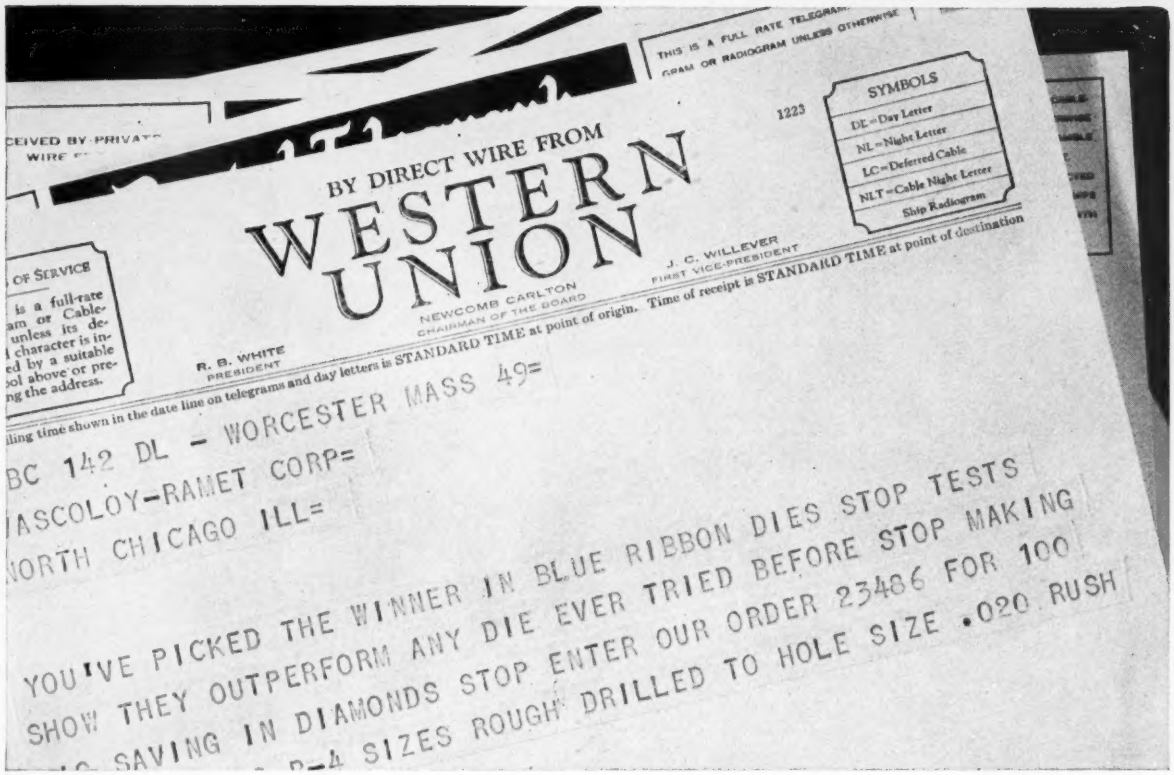
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On The Subject

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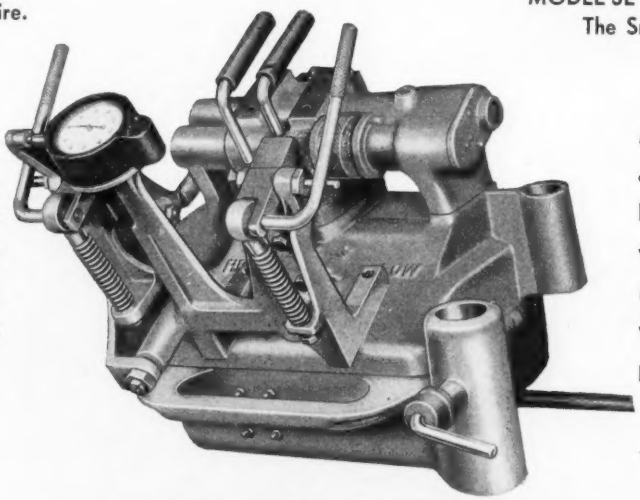

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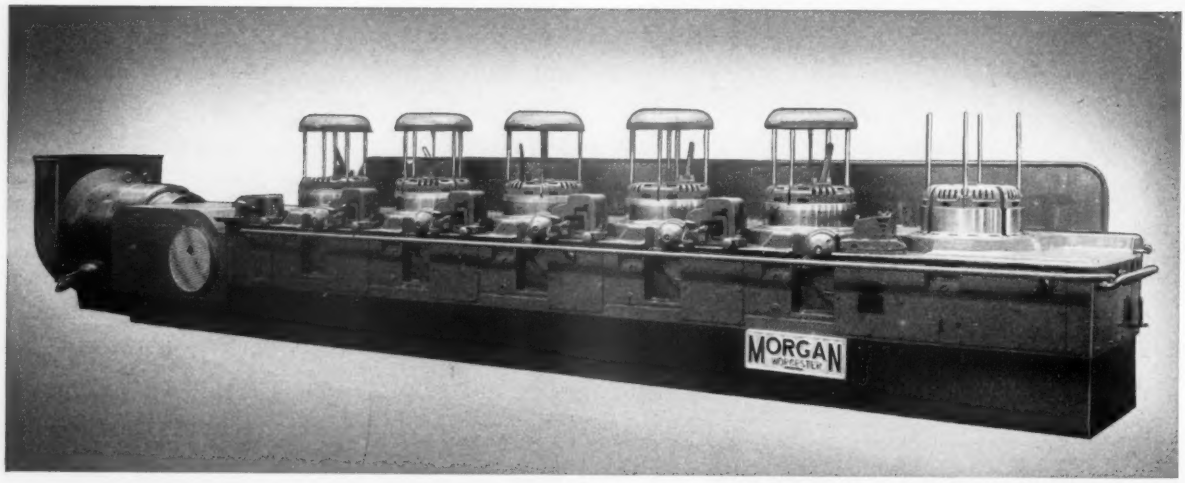

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Vol. 15 NOVEMBER, 1940 No. 11

Designated as

Official Publication By The Wire Association

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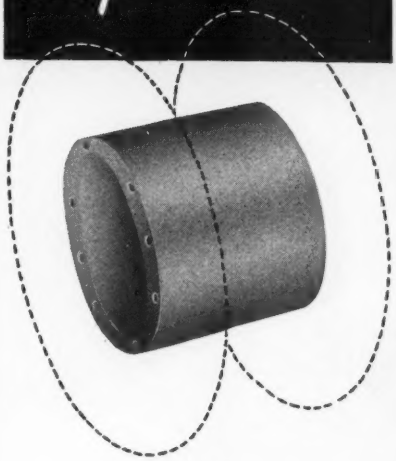

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Vol. 15 NOVEMBER, 1940 No. 11

Galvanizing Characteristics of Different Types of Steel

PART I

By Robert W. Sandelin,
Metallurgist,
Atlantic Steel Co., Atlanta, Ga.

— WIRE ASSOCIATION MEDAL AWARD PAPER - 1940 —

Introductory

IN evaluating the quality of a hot-dip galvanized coating one would necessarily consider several factors, chief among these would be: **(a) Thickness or weight of coating, (b) tenacity or adherence to the steel base, and (c) appearance of the galvanizing itself.**

✦ ✦ ✦

OBVIOUSLY a zinc coating is applied for protection it affords the steel base against the various elements of corrosion, hence the thickness or weight of the coat is in a sense a fair measure of its protective value. Heavy coatings in most cases would therefore be more desirable than lighter coatings when considering its corrosion resistance only.

✦ ✦ ✦

ON the other hand, a zinc coating which fails to adhere strongly to the steel base so that the coat flakes or peels off during some fabrication job such as bending or stamping or while in service, thereby exposing the otherwise unprotected steel base beneath, has failed in its purpose and the useful life of the product is materially decreased. For this reason, then, the adherence of a coating is in many cases at least a factor of utmost importance.

✦ ✦ ✦

LAST, but certainly not the least in importance, are the factors concerned with the surface appearance of the coating. It is a fact that the trade is partial toward galvanized products having bright, shiny, smooth, spangled coatings. In fact, in many cases a pleasing outward appearance of the coating is sufficient to sell the product regardless of its potential protective value. ✦ ✦ ✦

ONE can readily conceive, therefore, that a very desirable, if not the ideal type of hot-dip galvanized coating, would consist of a heavy, adherent, bright, smooth, spangled layer over the steel base. This ideal coating is not readily achieved, however, for various reasons, chief among these being faulty galvanizing technique and the improper selection or choice of steel to be galvanized for a particular purpose.

✦ ✦ ✦

THE published literature in the particular field of hot-dip galvanizing concerned with the effects

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PART I

Review of the Literature; Experimental Materials; Experimental Methods; Effect of Composition on Coating Appearances; Effect of Composition on Coating Adherence; Bibliography. ✦ ✦ ✦ ✦

PART II

(To be published in December, 1940)

Effect of Composition on Coating Weight; Effect of Composition on Coating Microstructure; Summary, Effects of Composition on Coating Properties. ✦ ✦ ✦ ✦

PART III

(To be published in January, 1941)

Effect of Composition on the Galvanizing of Wire; Effect of Composition on the Galvanizing of Bars. ✦ ✦ ✦ ✦

Designated as Official Publication by the Wire Association

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of the composition of the steel base on the quality factors of a coating are not very extensive. Much of this literature is concerned with the effect of the steel base on the appearance, most particularly in regard to the occurrence of the so-called "gray sheet". **Hannah and Rhead (1)**[1] concluded that impurities in the zinc bath were the primary cause of such defects and that the nature of the steel base had little or no effect. Their conclusions, arrived at as a result of laboratory experiments, are unwarranted in view of data obtained by other investigators, (2), (3). **Poppleton (4)** concluded as a result of mill practice that overpickling is a cause for non-spangled gray sheets. **White (5)** has shown that the quality of the steel base plays an important part in the occurrence of gray areas on sheets. He noted that gray sheets stripped of their gray-zinc coating and regalvanized persisted in turning gray whereas other sheets galvanized at the same time under identical conditions did not turn gray but had bright spangled surfaces instead. **White** concluded that the retention of hydrogen by the iron or steel during pickling operations was the cause of gray sheets. He further noted that the alloy layer, after stripping off the top layer, had numerous elevations of blisters which were supposedly caused by the evolution of hydrogen during the galvanizing process; the roughened surface thereby providing numerous neuclei causing an indistinct spangle.

✦ ✦ ✦

OTHER investigators, **Rosenberg (6)** and **Singmaster (7)**, have concluded that the spangle is no indication of quality and that some users demand a sheet "free from spangle" for high grade products. Such users, however, are an exception to the general class of buyers and consumers of galvanized products. **M. von Schwarz** and **Fromm (8)** in their recent work concluded that the more completely the carbon was precipitated in low carburized sheets during annealing as grain boundary cementite the more uniform was the galvanizing, and that the galvanizing was inferior where pearlite occurred along with the grain boundary cementite. This was attributed to the action of hydrogen which penetrates during pickling into any discontinuities in the grain structure and is driven out again by the heat of the galvanizing bath and thus disturbs the crystallization of the zinc.

✦ ✦ ✦

THE writer (9) found that gray spots or areas on galvanized strip were confined to certain heats of steel and that these steels would produce grayness on the surface regardless of whether or not they had been pickled in acid. Pickling did increase and accentuate the tendency of a steel to produce gray galvanized surfaces, however, but the tendency to cause grayness on the surface was not produced by pickling alone. Furthermore, microscopic examination of the coating over these gray areas indicated that the layer was composed entirely of iron-zinc alloy whereas the bright spangled portions showed a relatively pure zinc layer over the alloy layers. The occurrence of gray sheets or areas upon sheet or strip was concluded to be caused by increased alloying action between the steel and the molten zinc, being confined to certain grades of steel according to their method of manufacture. It was shown that grayness could be minimized in the plant by observing certain precautionary measures in practice.

R. W. SANDELIN
Graduated from the University of Minnesota 1931; instructor in Metallurgy at the Georgia School of Technology 1931-1934; Metallurgist for the Atlantic Steel Company, Atlanta, Georgia, 1934 to date. Member of The Wire Association.

✦ ✦ ✦

CAMP and **Francis** (3) state that the base metal of sheets producing gray coatings are very porous, permeable to hydrogen and show effects of overoxidation, adding that in the opinion of some this defect is attributed mainly to oxides in the steel.

✦ ✦ ✦

THE statements by **Camp** and **Francis** are not substantiated by data or references to such work. Data contained in this and a previous paper (9) show that such statements are not consistent with the fact that rimmed steels, which are certainly highly if not overoxidized and also porous, consistently galvanize brighter and with a spangle than the denser silicon-killed steels which invariably turn gray when galvanized under the same conditions.

✦ ✦ ✦

IN regard to specific effects of the composition of the steel, **Imhoff (10)** has pointed out the fact that differences in weights of the coatings do occur with different base metals. He states that wrought iron takes on a very much heavier coating than steel when galvanized under the same conditions. He also mentions that differences in coating weights may be expected when galvanizing malleable, cast and gray iron. However, aside from such general statements no other specific information is given. **Hanley (11)**, in a recent article reviewing the process of the hot-dip galvanizing process, mentions the effect of steel composition but fails to give any information on the subject and merely outlined briefly the **"Armco Zincgrip"** process. No composition was given.

✦ ✦ ✦

BABLIK (12) comments on the effect of composition in a general way stating that, "Naturally the ease with which iron is galvanized will increase the less amelattic admixtures it contains and this — besides the covering with cast-iron sand—is the reason why grey cast iron with its inclusion of graphite needles is occasionally so difficult to galvanize."

1. **The figures appearing in parentheses refer to the bibliography appended to this paper.**

WITH reference to steels, **Bablik** states that the structural form in which the carbon is present is important, that is, whether it is in the form of grain boundary pearlite or cementite. However, no data is given to illustrate the effects mentioned.

✦ ✦ ✦

IN regard to the effects of silicon, the following statement is quoted in full: "From this table, for instance, definite conclusions may be drawn with respect to the silicon content. In cases where the silicon is present in the form of Si oxide, as in that of the **Konigshof** sheet iron, galvanization of this sheet iron was not possible. If, however, the Si was present in the form of a crystalline solid, such as was the case with the **John Lysaght** brand, this non-metal present in the mixed crystal works in the direction of decreasing the reactivity of the iron and thus causes a decrease in the absorption of zinc."

✦ ✦ ✦

THE table referred to above is shown as Table A.

✦ ✦ ✦

THE statement made by **Bablik** to the effect that the silicon in the **"Konigshof"** sheet steel is present in the form of the oxide whereas in the **"John Lysaght"** steel it was present in the form of a crystalline solid seems to the writer to be a misstatement of fact and is quite untenable since it seems quite unlikely that 1.63 per cent of silicon could be present in the form of SiO_2.

✦ ✦ ✦

DATA presented in the table reproduced above cannot be entirely conclusive in that no attempt was made to control other variables having influence upon the results. Some of these variables are: (1) Analysis of the other elements, and (2) thickness of the test specimen. It is not mentioned whether or not the test conditions for samples were identical or comparable. Other factors having a bearing on these results would include: (1) Temperature of the spelter, (2) time in spelter, (3) pickling and fluxing conditions, and (4) galvanizing conditions.

IN regard to the appearance of a hot-dip galvanized coating, **Bablik** comments on, in addition to other factors, the effects of the composition of the steel base, having particular reference to the gray sheet.

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HE states, "In the case of sheet iron which is designated as grey sheet, the formation of hydrogen is usually so great, as a result of the peculiar composition of the iron, that a complete moistening of the iron is quite out of the question".

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BABLIK further states that it is the hydrogen breaking through the surface of the zinc which is the cause of the gray appearance. However, no quantitative data concerning the presence or amount of hydrogen either prior to or after galvanizing is given.

✦ ✦ ✦

IN summarizing the literature regarding the role of the steel base as affecting the quality of galvanizing, the results are not very consistent and are in some cases contradictory. Most of the previous work has been concerned with the occurrence of the so-called gray sheet. The gray appearance is supposedly caused by: (1) Escape of hydrogen through the coating, (2) porosity, (3) over-oxidation of the steel, (4) impurities in the zinc bath, (5) slag inclusions, and (6) formation of a complete alloy layer extending to the outer surface of the coating.

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IN regard to the other quality factors, such as adherence and weight of coating as being affected by the composition of the base metal, very little is to be found. As mentioned, **Bablik,** on the basis of only two steels varying widely in analysis besides the silicon content and also in thickness of section, stated that increased silicon content caused a decrease in the absorption of zinc. The effects of other elements as affecting galvanizing are not available in published literature.

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THE present study consists of investigating the specific effects of variations in composition of the steel base upon the following items, namely: (1) Appearance of the galvanized surface, (2) tenacity or adherence of the coating to the base metal, (3) weight, as expressed in ounces of zinc per square foot of galvanized surface, (4) metallographic characteristics of the structure of the coating, and (5) relative differences in the mutual diffusibility of zinc in contact with the various steels in the solid state.

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Materials

IN all, 72 steels were prepared for this investigation. In order to obtain a series of samples in which only the desired element could be varied and all the others be held

TABLE A
(from "Galvanizing" by Henry Bablik 2nd Ed., pp 155; E. & F. N. Spon, Ltd., London.)

Origin of the Sheet Iron Samples	Thickness of sheets. mm.	C	Si	Mn	S	P	Absorption of zinc in g. per sheet 1 x 2 m.
Krieglach, Stmk., Austria	0.3	0.15	0.024	0.43	0.06	0.037	1589
	0.5	0.21	0.013	0.53	0.06	0.020	2030
	1.0	0.13	0.011	0.50	0.06	0.058	1305
	2.0	0.14	0.009	0.56	0.05	0.086	1672
Bohler & Co., Stmk., Austria	0.5	0.57	0.25	0.87	0.02	0.04	1556
	0.8	1.31	0.15	0.44	0.04	0.015	1373
Konigshof, C. S. R.	0.5	0.13	1.63	0.44	0.06	0.05	...
Thale, Germany	0.8	0.10	0.044	0.63	0.02	0.03	1653
John Lysaght, England	0.3	0.11	4.1	0.006	0.01	0.028	625

constant, the procedure of making additions to the ingot molds was decided upon. In this way all other variables, not only those of composition alone, could be held under control. However, in order to check the validity of some of the results derived from mold additions as being applicable to individual heats, several individual heats were also included in these tests. Sixty-four (64) steels were obtained by making mold additions to seven (7) different heats of steel; the eight (8) remaining steels were from selected individual heats. In all, then, seventy-two (72) steels from fifteen (15) individual heats were prepared for this investigation as listed in Table I.

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THE mold additions consisted of either ferro-alloys or the pure metals, added to ingot molds as the heat was being poured. The 4000 pound ingot was later rolled into 1½" billets. From the middle of each of these ingots were cut two six-foot lengths to be used for the samples. One of these billets was then rolled into 1¾" x 18 gauge hot-rolled strip since it was thought at first that these would be the most suitable form for the experimental work. However, these hot-rolled strip samples proved to be unsatisfactory for the reason that their surface smoothness (after pickling) varied considerably and affected the drainage of the zinc as the samples were withdrawn from the spelter. This was due to the fact that all of the samples were not rolled at the same time, and this fact introduced such variables as differences in furnace temperature, in length of time in the reheating furnace and in the smoothness of the passes on the finishing rolls.

Fig. 1 Typical sample for galvanizing tests, approximately actual size except for length which was six inches. All surfaces ground to same degree of smoothness. ✦ ✦ ✦

MATERIALS
Table I

Steel No.	Series	Heat No.	C	P	S	Mn	Cu	Si
1	A	2895	.06	.019	.026	.42	.233	.106
2	B	3626	.17	.019	.032	.48	.235	.015
3	C	2913	.32	.017	.027	.50	.191	.127
4	D	1071	.10	.011	.024	.44	.310	.0094
5	E	2959	.11	.015	.028	.42	.175	.0090
6	F	2178	.05	.011	.026	.45	.229	.120
7	G	1029	.10	.099	.035	.39	.292	.220
8	H	2820	.10	.014	.028	.47	.370	.008
9	H	2821	.10	.057	.028	.39	.387	.005
10	H	3575	.10	.070	.027	.41	.263	.124
11	H	1082	.10	.077	.027	.44	.302	.292
12	H	1083	.10	.010	.020	.43	.216	.270
13	H	2194	.05	.009	.020	.27	.182	.002
14	H	3687	.05	.010	.020	.30	.173	.003
15	H	1833	.19	.018	.075	.90	.200	.121

IN order to eliminate the effects of such variables it was decided to cut square, smooth samples from the billets. The samples were cut and then precision ground to give identical highly polished surfaces, the overall dimensions of the finished specimen being ½" x ½" x 6". Figure 1 shows a typical sample. The chemical analyses were made on drillings obtained from the billet samples.

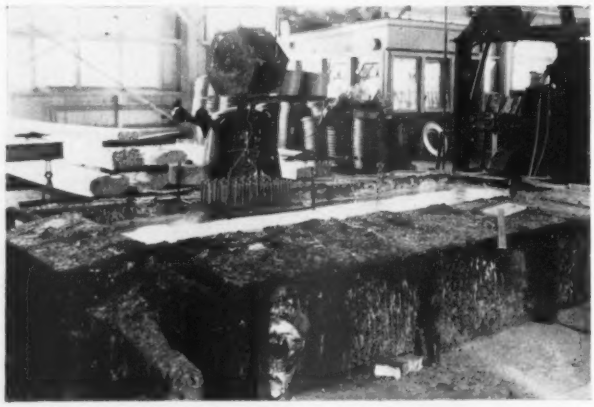

Fig. 2. Rack holding seventy-two samples being manipulated by an overhead crane. View shows samples just prior to immersion in the molten spelter.

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SERIES A: The ten steels for this series of samples were obtained from Heat No. 2895 which had a base composition of 0.06 per cent carbon, 0.019 per cent phosphorus, 0.026 per cent sulphur, 0.42 per cent manganese, 0.233 per cent copper, and 0.106 per cent silicon. Steels 1 and 2 varied in copper content

Table II
Series A

Base Composition	C	P	S	Mn	Cu	Si
Heat 2895 (Sample 10)	.06	.019	.026	.42	.233	.106

No.	% Copper	No.	% Silicon	No.	% Manganese	No.	% Phosphorus
10	.233	10	.106	10	.42	10	.019
1	.356	3	.220	6	.60	8	.042
2	.626	4	.348	7	.84	9	.086
		5	.610				

Table III
Series B

Base Composition	C	P	S	Mn	Cu	Si
Heat 3626 (Sample 10)	.17	.019	.032	.48	.235	.015

No.	% Copper	No.	% Silicon	No.	% Manganese	No.	% Phosphorus
10	.235	10	.015	10	.48	10	.012
1	.388	3	.132	6	.73	8	.045
2	.676	4	.249	7	.85	9	.084
		5	.508				

as shown in Table II, all other analysis figures being the same as for the base composition. Steels 3, 4 and 5 varied in silicon content only whereas steels 6 and 7, and 8 and 9 varied in their manganese and phosphorus contents respectively. Steel No. 10 was a sample taken from an ingot of the parent heat itself to which no additions had been made, and thus represents the base point in each of the individual groups in which comparisons were made.

✦ ✦ ✦

SERIES B, C, D, E, F and G: The fifty-four steels in these series were obtained from six individual heats as shown in Table I. Series D steels were not included in the summary of experimental listed in the following tables since these results were practically the same as those obtained from Series E. The higher residual copper in Series D apparently had no important bearing on the results obtained; for this reason, then, the results of tests on this series were generally omitted.

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IN each of these series the steels are grouped according to analysis, each varying from the base composition.

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SERIES H: The eight steels included in this series were obtained from eight different heats, which were selected on the basis of their chemical compositions as being suitable for the comparisons contemplated.

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THE complete analysis and identity of these steels are shown in the accompanying tables: II to XIII inclusive:

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Experimental Galvanizing Procedure

IN order to galvanize all of the samples in an identical manner it was necessary to place all of them in a specially constructed rack which held all of the samples upright and which could be manipulated by an overhead crane. Figure 2 shows the frame with 72 samples held over the spelter pan prior to immersion. The rack for holding these samples was merely a frame constructed of light angle

Table IV
Series C

Base Composition	C	P	S	Mn	Cu	Si
Heat 2913 (Sample 10)	.32	.017	.027	.50	.191	.127

No.	% Copper	No.	% Silicon	No.	% Manganese	No.	% Phosphorus
10	.191	10	.127	10	.50	10	.017
1	.358	3	.248	6	.69	8	.040
2	.600	4	.357	7	.89	9	.080
		5	.625				

Table V
Series E-1

Phosphorus — Copper

Base Composition	C	P	S	Mn	Cu	Si
Heat 2959 (Sample 12)	.11	.015	.028	.42	.175	.009

Sample No.	% Phosphorus	% Copper	Remarks
12	.015	.175	low P, low Cu
1	.070	.175	high P, low Cu
3	.015	.470	low P, high Cu
8	.060	.470	high P, high Cu
10 S	.033	.175	medium P, low Cu

Table VI
Series E-2

Phosphorus — Silicon

Base Composition	C	P	S	Mn	Cu	Si
Heat 2959 (Sample 12)	.11	.015	.028	.42	.175	.009

Sample No.	% Phosphorus	% Copper	Remarks
12	.015	.009	low P, low Si
1	.070	.009	high P, low Si
4	.015	.412	low P, high Si
7	.086	.570	high P, high Si

Table VII
Series E-3

Silicon — Copper

Base Composition	C	P	S	Mn	Cu	Si
	.11	.015	.028	.42	.175	.009

Sample No.	% Silicon	% Copper	Remarks
12	.009	.175	low Si, low Cu
4	.412	.175	high Si, low Cu
3	.009	.470	low Si, high Cu
5	.436	.400	high Si, high Cu

Table VIII
Series E-4

Phosphorus — Silicon — Copper

Base Composition	C	P	S	Mn	Cu	Si
	.11	.015	.028	.42	.175	.009

Sample No.	% Phos.	% Silicon	% Copper	Remarks
12	.015	.009	.175	low P, low Si, low Cu
2	.015	.009	.289	low P, low Si, high Cu
5	.015	.436	.400	low P, high Si, high Cu
1	.070	.009	.175	high P, low Si, low Cu
10	.066	.099	.299	high P, low Si, high Cu
9	.080	.568	.377	high P, high Si, high Cu
4	.015	.412	.175	low P, high Si, low Cu
7	.086	.570	.175	high P, high Si, low Cu
11	.070	.560	.475	high P, high Si, high Cu

iron, the overall dimensions of the base being 24″ x 24″ square. Four racks or frames were constructed to accommodate the 288 samples, 72 per frame, which were galvanized.

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THE immersion times for galvanizing were: (1) 30 seconds, (2) 60 seconds and (3) 180 seconds. In other words, one complete set was galvanized for ½ minute immersion, the other two for 1 and 3 minutes respectively. The fourth rack, which was used for making the bend tests was galvanized for 30 seconds or ½ minute.

✦ ✦ ✦

THESE immersion times were chosen since they represent the extremes in minimum and maximum galvanizing times ordinarily encountered in commercial practice with the shorter immersion times more nearly representing average practice. For the bend test samples the shortest immersion time was selected since long immersion times increase the brittleness of the coatings thus making comparisons of bend tests more difficult, and also for the reason previously mentioned, namely, that ½ minute more nearly represents average practice. The procedure for galvanizing each rack of samples consisted of the following steps: (1) Immersion for 15 seconds in **"Oakite"**, a commercial cleaner, for degreasing the samples, (2) rinse in cold running water, (3) immerse in H_2SO_4 at 160°F, commercial **"Rodine"** inhibitor used, for 5 seconds, (4) water rinse in cold running water to remove acid, (5) immerse in a zinc ammonium chloride, $ZnCl_2$ - 3 NH_4Cl, flux solution, 20°Be, 150° F, for 15 seconds, (6) allow to drain and dry, then (7) immerse in spelter at 850°F for 30, 60 or 180 seconds, (8) allow to drain and permit coatings to solidify over spelter pan, mill temperature 90°F with no wind effects, before removing rack from crane hook.

✦ ✦ ✦

"OAKITE" was used as a precautionary measure to remove any possible light grease or oil films resulting from handling the samples despite careful wiping with clean dry cloths. The acid pickle was necessarily very short and was merely another precautionary measure to insure a perfectly clean surface. The water rinses were made in a clear, constantly changing water to insure avoidance of contamination due to dissolved iron salts which sometimes occur when the water is not changed. Spelter temperature of 850°F was decided upon as representing average commercial practice.

Table IX
Series F-1

Carbon

Base Composition	C	P	S	Mn	Cu	Si
Heat 2178 (Sample 8)	.05	.011	.026	.45	.229	.120

Sample No.	% Carbon
8	.05
1	.20
2	.35

Table X
Series F-2

Titanium

Base Composition	C	P	S	Mn	Cu	Si
Heat 2178 (Sample 8)	.05	.011	.026	.45	.229	.120

Sample No.	% Titanium
8	.000
3	.042
4	.100
5	.169

Table XI
Series F-3

Aluminum

Base Composition	C	P	S	Mn	Cu	Si
Heat 2178 (Sample 8)	.05	.011	.026	.45	.229	.120

Sample No.	% Aluminum
8	trace
6	.145
7	.303

Table XII
Series G

Base Composition	C	P	S	Mn	Cu	Si
Heat 1029 (Sample P-1	.10	.099	.035	.39	.292	.218

Sample No.	% Phosphorus	% Silicon
P-1	.099	.218
P-2	.099	.500

Table XIII
Series H

Individual Heats

Sample No.	Heat No.	C	P	S	Mn	Cu	Si
B-1	2820	.10	.014	.028	.47	.370	.008
B-2	2821	.10	.050	.028	.39	.387	.005
B-3	3575	.10	.070	.027	.41	.342	.184
B-4	1082	.10	.077	.027	.44	.302	.302
B-5	1083	.10	.010	.020	.43	.216	.270
R-1	2194	.05	.009	.020	.27	.182	.002
R-2	3687	.05	.010	.020	.30	.173	.003
S-1	1833	.19	.018	.075	.90	.200	.121

Effects of Composition Upon Appearance

BEFORE discussing the individual groups of steels in the various series it might be said as an introductory statement that the differences in appearance were outstanding. Some of the samples had bright, shiny, smooth, spangled coatings, others had dark gray smooth coats, with some the coat light gray and smooth while still others had rough or streaked coatings with a varying degree of luster. In all cases there was a remarkable consistency compatible with the analysis of the specimen and the length of immersion time. It was indeed interesting if not exciting to observe the degree of contrast exhibited by many of the test specimens.

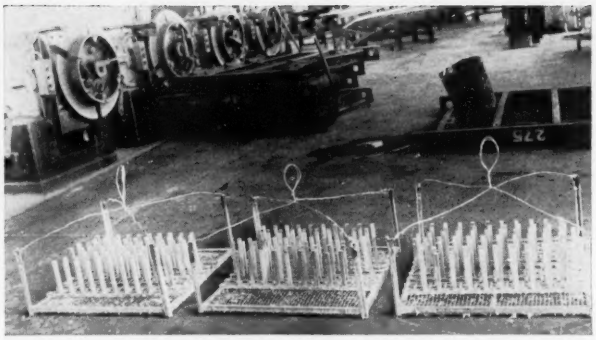

Fig. 3. Three racks of samples just after galvanizing, fourth rack of samples used for the bend tests not shown in this view.

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Series A

THE effects of variation from the base composition upon the appearance of the samples are shown in Table XIV. From these data it can be noted that both copper and manganese additions have no noticeable effect upon appearance.

✦ ✦ ✦

THE effect of silicon was odd in that at .220% Si there was a noticeable tendency toward forming a bright, spangled coating. This tendency became more pronounced with increased immersion time. It is perhaps significant that this specimen had the lightest zinc coating. Sample 4 which showed a tendency toward brightness at the 3 minute immersion had the second lightest coating.

✦ ✦ ✦

THE effect of increased phosphorus content was to increase the tendency toward the formation of a bright coating. Increasing the immersion time also increased the tendency toward forming a bright coat. These effects were not pronounced, however, except for the 3 minute immersion.

Series B

EFFECTS of variation in analysis from the base composition upon the appearance of specimens in this series are shown in Table XV. Here again we note that copper or manganese additions have no noticeable effect upon appearance except to cause the appearance of a few light ridges or streaks along the length of the sample. This effect would ordinarily escape detection and does not appear to have any practical importance.

✦ ✦ ✦

THE effect of small silicon additions is very pronounced, changing the appearance from a bright, shiny spangled coating to a dark gray finish of satin smoothness. Here again we observe a tendency for brightening at the 3 minute immersion with sample 4 which had .249% Si, although the tendency was not as marked as with sample 3, Series A.

✦ ✦ ✦

IN this series where the base sample has a bright, smooth spangled coating, the effect of increased phosphorus is to cause grayness and roughness depending upon the amount present. At the long immersion time the effect was to increase roughness and thickness to the extent that the slow drainage from the surface caused considerable zinc to remain and freeze, causing a bright but rough coating with an indistinct or indiscernible spangle. The roughness had a distinct streaked effect.

Table XIV

Series A

Base Composition:		C	P	S	Mn	Cu	Si
Heat 2895 (Sample 10)		.06	.019	.026	.42	.233	.106

Appearance of Galvanized Coating

Sample	Analysis	30 seconds	60 seconds	180 seconds
10	.223% Cu	Dark gray, smooth	Dark gray, smooth	Dark gray, smooth
1	.356% Cu	" " , "	" " , "	" " , "
2	.626% Cu	" " , "	" " , "	" " , "
10	.106% Si	Dark gray, smooth	Dark gray, smooth	Dark gray, smooth
3	.220% Si	Dark gray, smooth lower 10% bright, shiny	Dark gray, smooth lower 15% bright, shiny	Entirely bright, shiny, spangled
4	.348% Si	Dark gray, smooth	Dark gray, smooth	Dark gray, smooth lower 35% bright, shiny
5	.610% Si	Dark gray, smooth	Dark gray, smooth	Dark gray, smooth
10	.42% Mn	Dark gray, smooth	Dark gray, smooth	Dark gray, smooth
6	.60% Mn	" " , "	" " , "	" " , "
7	.84% Mn	" " , "	" " , "	" " , "
10	.019% P	Dark gray, smooth	Dark gray, smooth	Dark gray, smooth
8	.042% P	" " , "	" " , "	Dark gray, smooth lower 30% bright, shiny
9	.086% P	Dark gray, smooth lower 10% bright, shiny	Dark gray, smooth lower 30% bright, shiny	Completely bright, shiny, spangled, smooth

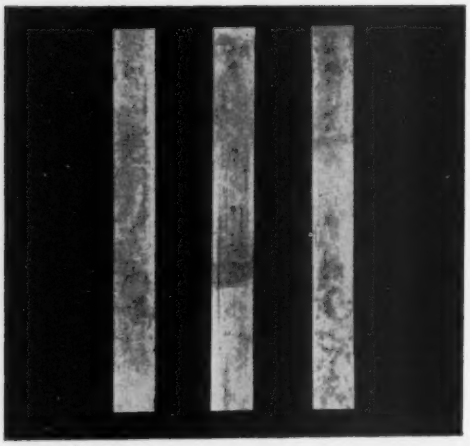

Fig. 4. Left to right, samples no. 10, 1 and 2, Series A, 30 second immersion. Appearance of base sample (10) is a dull gray; the addition of increasing amounts of copper is without any noticeable effect. All samples shown in Figures 4 to 36 inclusive are approximately ¾ actual size.

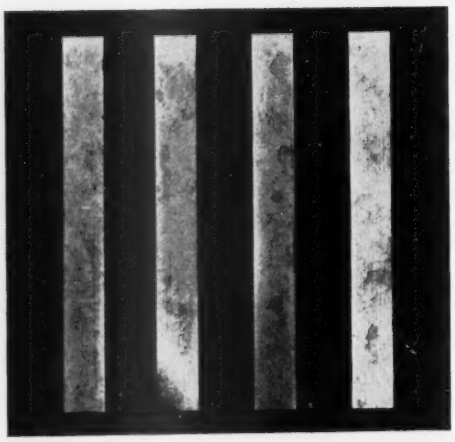

Fig. 5. Left to right, samples 10, 3, 4 and 5, Series A, 30 second immersion. Sample 3 with 0.220% silicon shows a trace of brightness at the bottom of the test sample.

✦ ✦ ✦

IN the case of samples 1, 2, 6, 7 and 10 there was a distinct building up of a ridge or edge on each of the four sharp corners. Metallographic examination of these corners revealed a building up of iron-zinc alloy at these points to the extent of forming a distinct ridge or fin.

✦ ✦ ✦

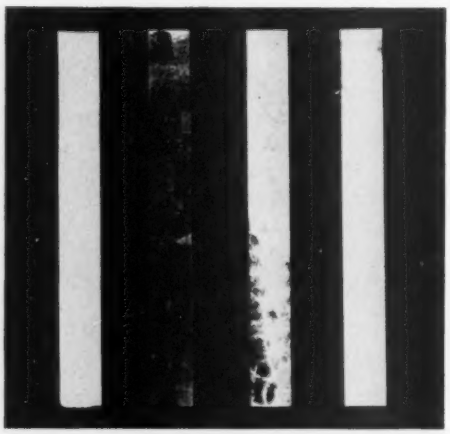

Fig. 6. Left to right, samples 10, 3, 4 and 5, Series A, 180 second immersion. Sample 3 with 0.220% silicon is completely bright, shiny and spangled, sample 4 with 0.348% silicon showed a tendency, though weak, to brighten at the long immersion time.

✦ ✦

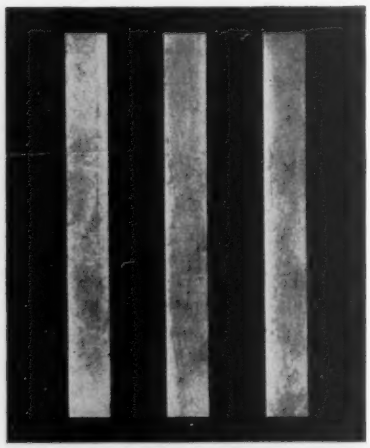

Fig. 7. Left to right, samples no. 10, 6 and 7, Series A. 30 second immersion. Appearance of base sample is a dull gray; the addition of increasing amounts of manganese is without effect.

Series C

IN this series of samples, as with the others preceding, copper showed no effect on the appearance of the coatings, the base sample in this series having a dark gray, smooth coating.

✦ ✦ ✦

THE effect of manganese differed slightly from Series A in that increased manganese content appeared to have a slight brightening effect which decreased with increased immersion time. This brightening effect was only slight and cannot be considered important.

✦ ✦ ✦

THE effect of silicon on appearance had its maximum effect, although so very slight as to be practically nil, at .248 per cent silicon.

✦ ✦ ✦

INCREASING the phosphorus content increased the tendency

Table XV
Series B

Base Composition:		C	P	S	Mn	Cu	Si
Heat 3626 (Sample 10)		.17	.019	.032	.48	.235	.015

Sample	Analysis	Appearance of Galvanized Coating 30 seconds	60 seconds	180 seconds
10	.235% Cu	Bright, spangled	Bright, spangled	Bright, spangled
1	.388% Cu	" , "	" , "	" , "
2	.676% Cu	" , "	" , "	" , "
10	.015% Si	Bright, spangled	Bright, spangled	Bright, spangled
3	.132% Si	Dark gray, smooth	Dark gray, smooth	Dark gray, smooth
4	.249% Si	" " , "	Dark gray, smooth lower 50% bright, shiny	Dark gray, smooth lower 60% bright, shiny
5	.508% Si	" " , "	Dark gray, smooth	Dark gray, smooth
10	.48% Mn	Bright, spangled	Bright, spangled	Bright, spangled
6	.73% Mn	" , "	" , "	" , "
7	.85% Mn	" , "	" , "	" , "
10	.019% P	Bright, spangled	Bright, spangled	Bright, spangled
8	.045% P	Lower 10% bright but no spangle, rough and streaked; near top light gray and rough roughness resembled innumerable small pits.	Same as for the 30 second immersion.	Bright, shiny but without spangle, also very rough with tendency toward streaks and pitting.
9	.084% P	Dark gray, smooth	Dark, gray, fairly rough	(same as above)

toward producing a bright coat, the effect being most pronounced at the highest phosphorus content and, of course, with maximum immersion time.

✦ ✦ ✦

Series E

DUE to the many combinations possible in this series, the results will be summarized rather than be tabulated since in practically all cases the results are the same as observed in Series A, B and C.

✦ ✦ ✦

THE effect of copper was nil in all combinations which checks previous results. In other words, high copper content had no effect in causing a bright spangled coating to turn gray or in causing a gray coating to become brighter. The various steel combinations illustrating the effect of copper are: 1 and 8, 1 and 10, 4 and 5, 7 and 11 or 9, 12 and 2, and 12 and 3.

✦ ✦ ✦

THE effect of phosphorus was the same as observed before, namely, that high phosphorus content—over 0.050 per cent, cause steels normally having a bright spangled coating to turn either a dark or light gray, depending upon the immersion time. With the phosphorus content under 0.050 per cent the coating was bright and lustrous but without a spangle; the

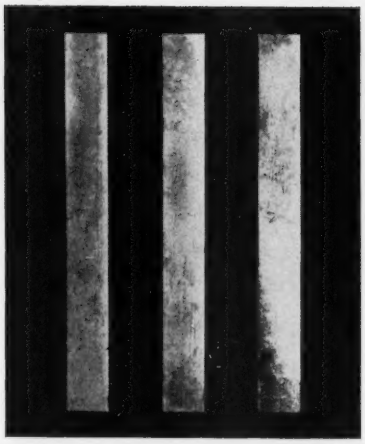

Fig. 8. Left to right, samples nos. 10, 8 and 9, Series A, 30 second immersion. Note that effect of the high phosphorus content is to increase tendency to galvanize with a bright coating although effect is very slight at the short immersion time. ✦ ✦ ✦ ✦

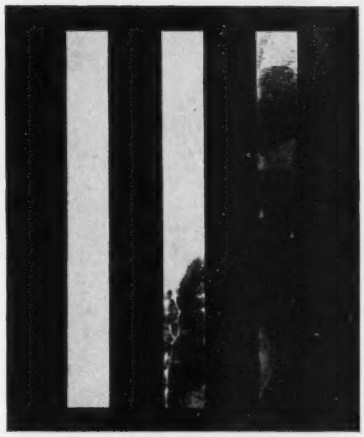

Fig. 9. Left to right, samples nos. 10, 8 and 9, Series A, 180 second immersion. The high phosphorus sample is completely bright while the medium phosphorus sample shows a marked tendency to brighten also at the long immersion time.

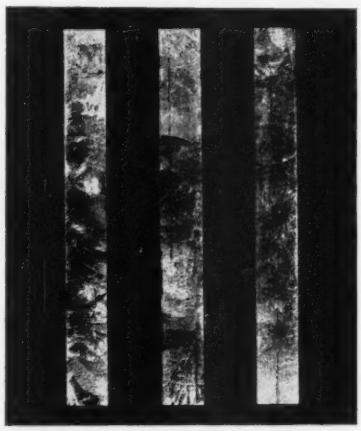

Fig. 10. Left to right, sample nos. 10, 1 and 2, Series B, 30 second immersion. Appearance of base sample is bright, shiny and spangled; the addition of increasing amounts of copper is without effect upon coating. ✦ ✦

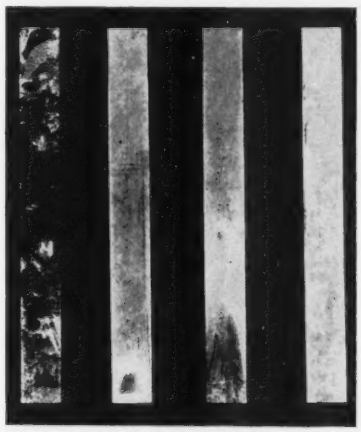

Fig. 11. Left to right, sample nos. 10, 3, 4 and 5, Series B, 30 second immersion. Note the slight tendency to brighten in sample 4, 0.249% Si, at this short immersion time. At the 180 second immersion this sample was 60% bright. ✦

Fig. 12. Left to right, sample nos. 10, 6 and 7, Series B, 30 second immersion. Note that increasing amounts of manganese have no effect upon the appearance of the base sample. ✦

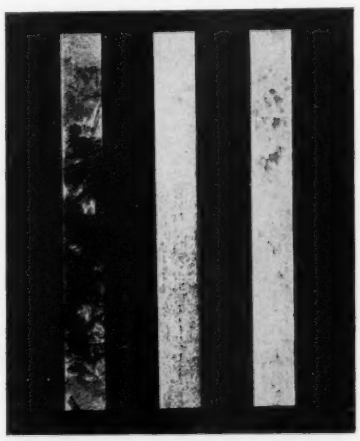

Fig. 13. Left to right, sample nos. 10, 8 and 9, Series B, 30 second immersion. The effect of increasing the phosphorus content to 0.045% changed the appearance to a semi-lustrous gray, brightest near the bottom. High phosphorus produced a uniformly dull gray color. ✦ ✦

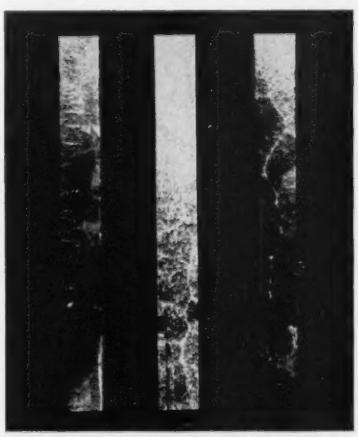

Fig. 14. Left to right, sample nos. 10, 8 and 9, Series B, 180 second immersion. Note the effect of increased time in bringing out the brightening tendency of the high phosphorus steel. Sample 9 was slightly rougher than sample 8 and did not photograph as well although it was completely bright. ✦ ✦ ✦ ✦

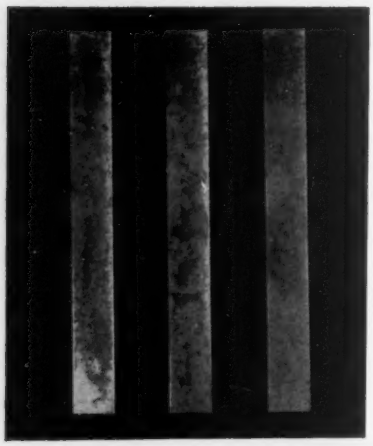

Fig. 15. Left to right, sample nos. 10, 1 and 2, Series C, 30 second immersion. The appearance of the base sample is a dull gray; the effect of increasing the copper content has no effect upon the appearance. ✦ ✦ ✦

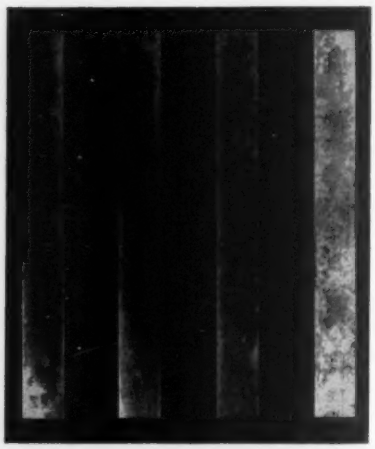

Fig. 16. Left to right, samples 10, 3, 4 and 5, Series C, 30 second immersion. All of these samples had a dull gray appearance. At 180 second immersion, sample 3, 0.248% Si, had a slight tendency to galvanize bright. ✦

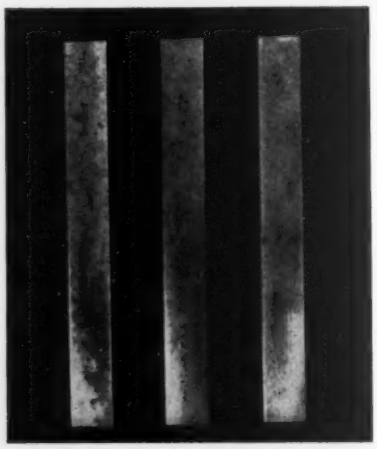

Fig. 17. Left to right, sample nos. 10, 6 and 7, Series C, 30 second immersion. The effect of increasing the manganese was without effect. The trace of brightness near the bottom on the manganese samples was noted only in this series. For the 180 second immersion the tendency to brighten was nil. ✦ ✦ ✦

surface was rough and streaked with the roughness increasing with increased immersion time. With long immersions, however, the tendency is to produce a bright shiny coating which is very rough. The effect of phosphorus is illustrated by the following combinations of steels: 12 and 1, 3 and 8, 2 and 10, 12 and 10, and, 12 and 10S.

✦ ✦ ✦

THE effect of silicon was to produce smooth dark gray coatings in all instances. In all cases, however, the silicon content was so high as to be out of that

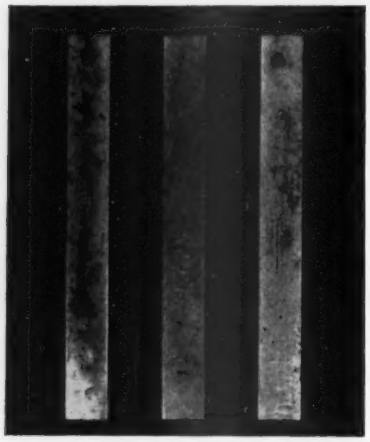

Fig. 18. Left to right, sample nos. 10, 8 and 9, Series C, 30 second immersion. Effect of increased phosphorus content not apparent at the short immersion time. Note fine hair line cracked, or fibrous appearance of sample 9. ✦ ✦

Fig. 19. Left to right, sample nos. 10, 8 and 9, Series C, 180 second immersion. Note tendency to galvanize with a bright coating with increased phosphorous content at the longer immersion time. ✦ ✦ ✦ ✦

Table XVI

Series C

Base Composition:	C	P	S	Mn	Cu	Si
Heat 2913 (Sample 10)	.32	.017	.027	.50	.191	.127

Appearance of Galvanized Coating

Sample	Analysis	30 seconds	60 seconds	180 seconds
10	.191% Cu	Dark gray, smooth	Dark gray, smooth	Dark gray, smooth
1	.358% Cu	" " , "	" " , "	" " , "
2	.600% Cu	" " , "	" " , "	" " , "
10	.127% Si	Dark gray, smooth	Dark gray, smooth	Dark gray, smooth
3	.248% Si	" " , "	" " , "	Dark gray, smooth, trace of brightness on bottom
4	.357% Si	" " , "	" " , "	Dark gray, smooth
5	.625% Si	" " , "	" " , "	" " , "
10	.50% Mn	Dark gray, smooth	Dark gray, smooth	Dark gray, smooth
6	.69% Mn	Dark gray, smooth lower 25% bright, shiny	Dark gray, smooth trace of brightness at bottom	" " , "
7	.89% Mn	Dark gray, smooth lower 55% bright, shiny	Dark gray, smooth lower 30% bright, shiny	" " , "
10	.017% P	Dark gray, smooth	Dark gray, smooth	Dark gray, smooth
8	.040% P	" " , "	" " , "	Dark gray, smooth lower 20% bright, shiny
9	.080% P	" " , "	" " , "	Dark gray, smooth lower 70% bright, smooth and spangled

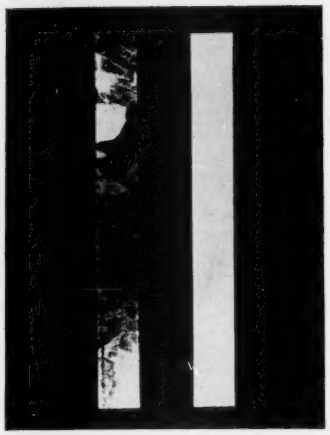

Fig. 20. Left to right, samples 12 and 4, Series E, 30 second immersion. Appearance of base sample is bright, shiny and spangled. Effect of adding silicon is to change appearance to a dull gray. ✦ ✦ ✦ ✦

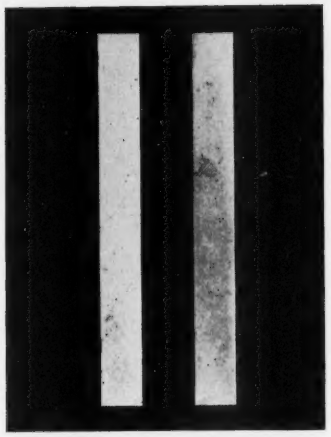

Fig. 21. Left to right, samples 1 and 7, with 0.070% P; and 0.086% P, and 0.570% Si respectively, Series E, 30 second immersion. Sample 1 is a lighter gray in color and has a characteristic 'woody' or grainy appearance. Sample 7 has a uniformly darker-gray appearance quite readily distinguishable at the shorter immersion time. ✦

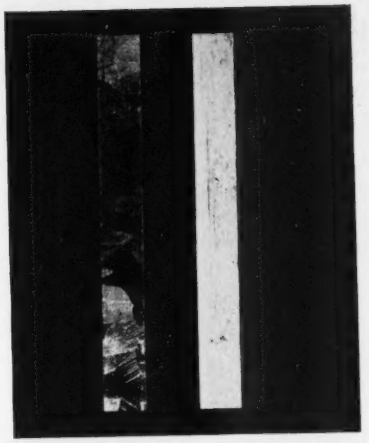

Fig. 22. Left to right, samples 12 and 1, Series E, 30 second immersion. Note effect of adding large percentages of phosphorus (from 0.015 to 0.070%) on the appearance of the base composition. ✦ ✦ ✦ ✦

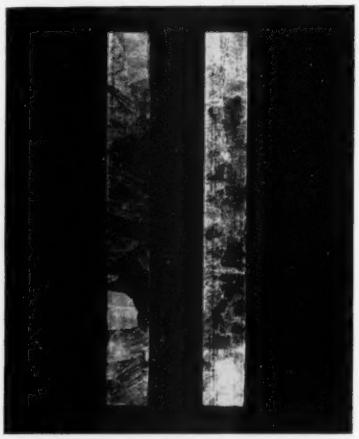

Fig. 23. Left to right, samples 12 and 10S, Series E, 30 second immersion. Sample 10S with 0.033% P, galvanized with a bright, shiny appearance, the spangle was indiscernible however, also the coating was slightly streaked and rough. ✦

"brightening" range which appears to be in the neighborhood of 0.20 - 0.30 per cent silicon. Steels 12 and 4,3 and 5, 2 and 5 illustrate this effect.

✦ ✦ ✦

IN considering the combinations of phosphorus, silicon and copper, copper can be eliminated from consideration since it had no noticeable effect on appearance in any instance. Therefore, only the combinations of phosphorus and silicon will be discussed.

✦ ✦ ✦

THE addition of phosphorus to high silicon steels has no noticeable effect on appearance since the appearance of the high silicon steel is dark gray. This effect is illustrated by steels 4 and 7. On the other hand the addition of silicon to high phosphorus steels changes the surface from a light gray, 'fibrous' appearance to a smooth, satin finish dark gray color. Therefore, it appears that silicon exerts the predominating effect in combinations of phosphorus and silicon assuming that the silicon content is very high, say over 0.30 per cent silicon.

✦ ✦ ✦

AT this point it is interesting to point out that the behavior of phosphorus-silicon steels depends on the silicon content as mentioned above. If the silicon content is under say 0.30 per cent silicon, then

Table XVII

Series E

Base Composition:	C	P	S	Mn	Cu	Si
Heat 2959 (Sample 12)	.11	.015	.028	.42	.175	.0090

Appearance of Galvanized Coating

Sample	30 seconds	60 seconds	180 seconds
12	Bright, smooth, spangled	Bright, smooth, spangled	Bright, smooth, spangled
1	Gray, smooth	Gray, smooth	Lower 10% bright, remainder light gray, rough
2	Bright, smooth, spangled	Bright, smooth, spangled	Bright, smooth, spangled
3	Bright, smooth, spangled	Bright, smooth, spangled	Bright, smooth, spangled
4	Dark gray, smooth	Dark gray, smooth	Dark gray, smooth
5	" " "	" " "	" " "
6	" " "	" " "	" " "
7	" " "	" " "	" " "
8	Gray, smooth	Gray, smooth	Entirely bright, slight spangle, streaked and rough
9	Dark gray, smooth	Dark gray, smooth	Dark gray, smooth
10	Gray, smooth	Gray, smooth	Lower 20% bright, remainder light gray, rough
10 S	Bright, lusturous, but no spangle, streaked	Bright, lustrous, but no spangle, streaked	Bright, lustrous, but no spangle, streaked
11	Dark gray, smooth	Dark gray, smooth	Dark gray, smooth

the effect of silicon is less predominant and the effect of phosphorus is noticed. This was noticed in Series D which was not included since the group as a whole was about the same as Series E except for a higher residual copper content. As has already been shown, copper exerts no effect upon appearance and so the series was not included. However, the phosphorus-silicon steels in that series are worth considering since in those combinations the silicon content was much lower than in Series E. Table XVIII and XIX, therefore, will be included here merely to illustrate this effect.

✦ ✦ ✦

THE effects of these various combinations on the appearance are shown in table XIX.

✦ ✦ ✦

HERE we observe that when the silicon content is lower (than Series E), the tendency is toward the formation of bright coatings with long immersions. This effect is also noted later in Series G with steels P-1 and P-2, and in Series H with steels B-3 and B-4.

✦ ✦ ✦

Series F

THE effects of variations from the base composition upon the appearance of the samples in this series are shown in Table XX.

✦ ✦ ✦

FROM these data we observe that increase in carbon content

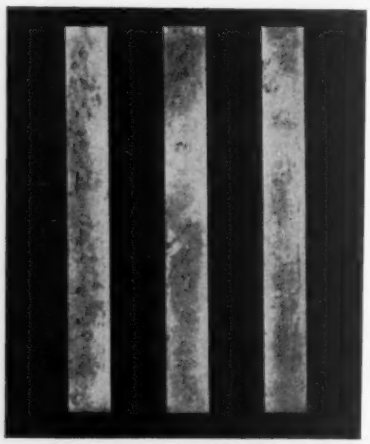

Fig. 24. Left to right, sample nos. 8, 1 and 2, Series F, 30 second immersion. The appearance of the base sample was a dull gray; the addition of carbon had no effect although at the 180 second immersion there was a very slight brightening effect near the bottom of the samples. ✦

Table XVIII
Series D-2

Phosphorus — Silicon

Base Composition:	C	P	S	Mn	Cu	Si
Heat 1071 (Sample 14)	.10	.011	.024	.44	.310	.0094

Sample No.	% Phosphorus	% Silicon	Remarks
14	.011	.0094	low P, low Si
1	.011	.214	low P, high Si
4	.087	.0094	high P, low Si
8	.057	.196	high P, high Si
13	.079	.187	high P, high Si

Table XIX
Series D-2

Appearance of Galvanized Coating

Sample No.	30 seconds	60 seconds	180 seconds
14	Bright, spangled	Bright, spangled	Bright, spangled
1	Lower 45% bright, remainder dark gray	Lower 55% bright, remainder dark gray	Entirely bright, smooth
4	Light gray, streaked	Light gray, streaked	Very light gray, streaked, had pitted appearance
8	Dark gray	Lower 30% bright, remainder dark gray	Lower 40% bright, remainder dark gray
13	Trace of brightness at bottom	Lower 70% bright, remainder dark gray	100% bright, spangled

Table XX

Base Composition:	C	P	S	Mn	Cu	Si
Heat 2178 (Sample 8)	.05	.011	.026	.45	.229	.120

Appearance of Galvanized Coating

Sample	Analysis	30 seconds	60 seconds	180 seconds
8	.05% C	Dark gray, smooth	Dark gray, smooth	Dark gray, smooth
1	.20% C	" " , "	" " , "	Lower 15% bright, remainder dark gray
2	.35% C	" " , "	" " , "	Lower 70% bright, remainder dark gray
8	.00 % Ti	Dark gray, smooth	Dark gray, smooth	Dark gray, smooth
3	.042% Ti	" " , "	Trace of brightness at bottom, remainder dark gray	Lower 10% bright remainder dark gray
4	.100% Ti	" " , "	Slightly more than above	Lower 30% bright remainder dark gray
5	.169% Ti	" " , "	Lower 5% bright, remainder dark gray	Lower 50% bright, remainder dark gray
8	Trace Al	Dark gray, smooth	Dark gray, smooth	Dark gray, smooth
6	.145% Al	Lower 5% bright, remainder gray	Lower 10% bright, remainder gray	Lower 90% bright, spangled and smooth, top gray
7	.303% Al	Lower 10% bright, remainder gray	Lower 15% bright, remainder gray	100% bright, spangled and smooth

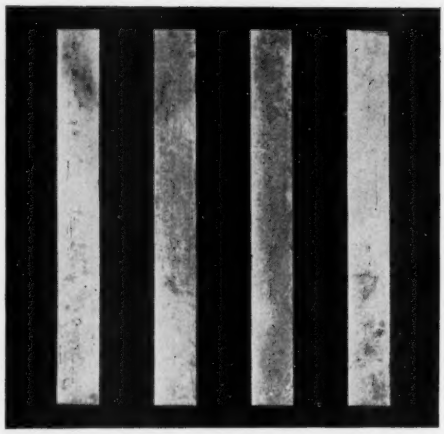

Fig. 25. Left to right, samples 8, 3, 4 and 5, Series F, 30 second immersion. Increasing amounts of titanium had no effect at the short immersion time. ✦

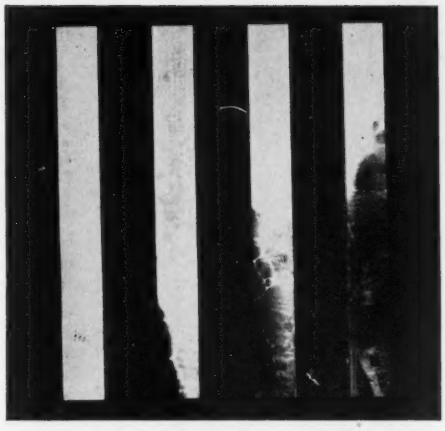

Fig. 26. Left to right, samples 8, 3, 4 and 5, Series F, 180 second immersion. Note the progressive increase in the tendency to galvanize bright with increasing amounts of titanium at the long immersion time. ✦

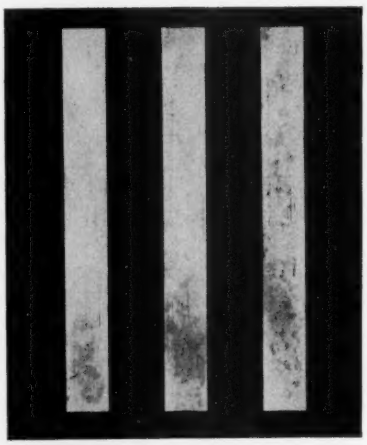

Fig. 27. Left to right, sample nos. 8, 6 and 7, Series F, 30 second immersion. There was a definite tendency to galvanize bright with increasing amounts of aluminum although the effect at the short immersion time was weak. ✦

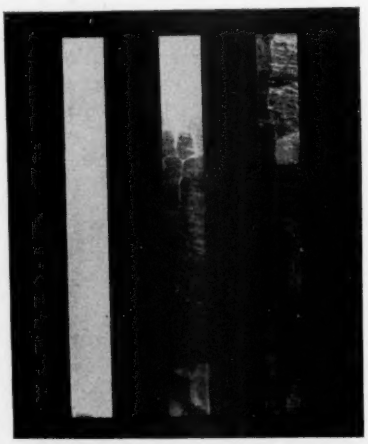

Fig. 28. Left to right, sample nos. 8, 6 and 7, Series F, 180 second immersion. The high aluminum sample was completely bright and sample 6 was about 90% bright. The tendency to galvanize bright was quite evident. ✦ ✦

tends to produce brighter coatings. However this effect is not observed except for long immersions.

✦ ✦ ✦

INCREASING the titanium content increases the tendency to produce a bright coating although the effects do not seem potent enough to be of importance.

✦ ✦ ✦

THE effect of aluminum was interesting in that it showed the greatest 'brightening' influence of any of the elements in this series, particularly at long immersions.

✦ ✦ ✦

Series G

ONLY two steels were included in this set being of the high phosphorus-high silicon variety. The effect of increasing the silicon content on a steel already high in silicon is shown in Table XXI.

✦ ✦ ✦

THE effect of increasing the silicon content was to increase the graying tendency which with steel P-2 persisted even at the 3 minute immersion.

Series H

THE eight steels in this particular series all came from separate heats and were chosen because their compositions were such as to make it possible to check back on and make comparisons with the heats to which additions had been made. The appearances of these steels galvanized at various immersion times are shown in Table XXII.

✦ ✦ ✦

A COMPARISON of the steels in this series indicates that low phosphorus, low silicon steels galvanize with bright coatings as illustrated by steel B-1. With an increase in phosphorus content to .050 per cent we obtain either smooth gray, rough gray or bright coatings depending upon the immersion time, as shown by steel B-2.

✦ ✦ ✦

HIGH phosphorus-high silicon steels behave differently according to their silicon content, the

Table XXI

Series G

Phosphorus — Silicon

Base Composition:	C	P	S	Mn	Cu	Si
Heat 1029 (Sample P-1)	.10	.099	.035	.39	.292	.218

Appearance of Galvanized Coating

Sample	Analysis	30 seconds	60 seconds	180 seconds
P-1	.218% Si	Dark gray, smooth	Dark gray, smooth	100% bright, spangled, a few light streaks
P-2	.500% Si	" " , "	" " , "	Dark gray, smooth

higher the silicon content, the greater will be the tendency to produce a gray smooth coating. This effect is shown by comparing steels B-3 and B-4. This effect of silicon has been commented upon before in discussing Series D and E and the results found in these separate heats corroborates the previously reported data.

✦ ✦ ✦

STEEL B-5 illustrates the effect of silicon in the range of .20 to .30 per cent silicon which exhibits a definite brightening tendency at long immersions. Comparing this steel with steel 10, Series A, and with steel 8, Series F we observe the same brightening effect in this particular range as

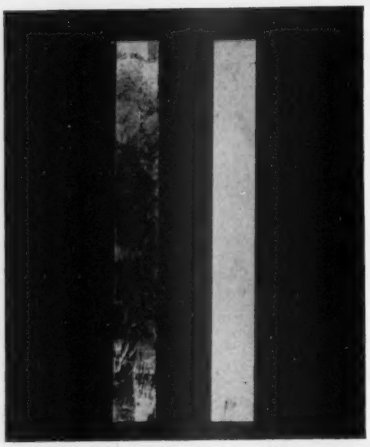

Fig. 29. Left to right, samples B-1 and B-5, Series H, 30 second immersion. B-1, the low phosphorus—low silicon steel galvanized with a bright, spangled coat. B-5, 0.270% Si, produced a gray coating. ✦ ✦ ✦

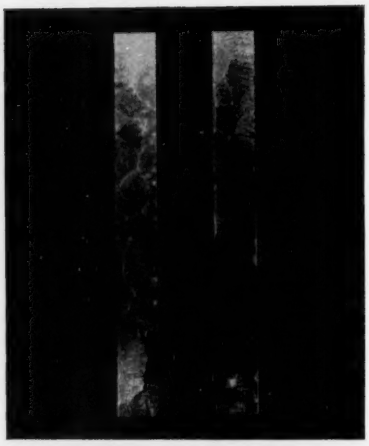

Fig. 30. Left to right, samples B-1 and B-5, Series H, 180 second immersion. B-5, with .270% Si, galvanized completely bright. This behavior is typical for silicon steels in the range 0.20 to 0.30% silicon. ✦ ✦ ✦

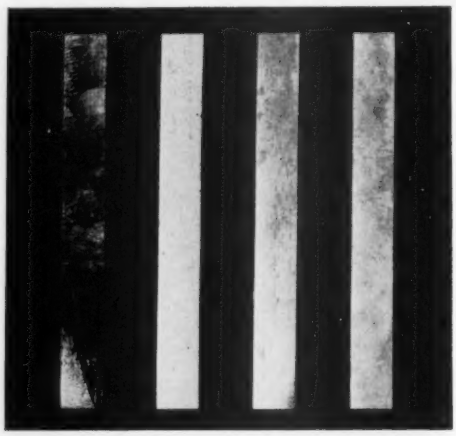

Fig. 31. Left to right, samples B-1, B-2, B-3 and B-4, Series H, 30 second immersion. All samples have a dull gray appearance except B-1 which is low in both phosphorus and silicon. ✦ ✦ ✦

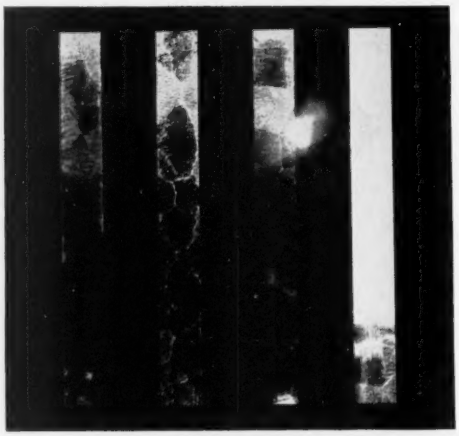

Fig. 32. Left to right, samples B-1, B-2, B-3 and B-4, Series H, 180 second immersion. All samples are bright and spangled except B-4 which had the highest silicon content with high phosphorus content. ✦ ✦

was observed within the silicon groups themselves in Series A, B and C.

✦ ✦ ✦

THE rimmed steels, R-1 and R-2, galvanized with bright, shiny, spangled coatings at all immersion times. Incidentally, the rimmed steel samples were forged down to size so that the rim pattern was normal. These steels would be expected to galvanize bright considering the fact that rimmed steels are normally low in phosphorus and silicon.

✦ ✦ ✦

ONE high sulphur steel was galvanized and, as shown in the table, the appearance was that of a silicon steel. The influence of sulphur was not obvious from

Table XXII

Series H

(Individual Heats)

	Appearance of Galvanized Coating		
Sample	**30 seconds**	**60 seconds**	**180 seconds**
B-1	Bright, spangled	Bright, spangled	Bright, spangled
B-2	Light gray	Light gray, slightly streaked	100% bright, spangled, slightly streaked
B-3	Dark gray, smooth	Lower 10% bright, remainder gray	100% bright, spangled, smooth
B-4	" " , "	Dark gray, smooth	Lower 20% bright, remainder gray
B-5	Trace of brightness at bottom, remainder dark gray	Lower 10% bright, remainder dark gray	100% bright, spangled, smooth
R-1	Bright, spangled, smooth	Bright, spangled, smooth	Bright, spangled, smooth
R-2	Bright, spangled, smooth	Bright, spangled, smooth	Bright, spangled, smooth
S-1	Dark gray, smooth	Dark gray, smooth	Dark gray, smooth

this test and apparently the effect is negligible, the appearance of the coating being influenced solely by the presence of silicon.

✦ ✦ ✦

IN the previous discussions concerning all of the series, it was noted that the grayness varied slightly in degree. No attempt was made to include these slight differences in the various Tables since it would have probably created confusion, however, they may now be briefly summarized.

✦ ✦ ✦

SILICON steels and silicon-phosphorus steels produced a gray color slightly darker and with a slightly smoother finish than those steels which contained phosphorus alone. With increased immersion time the gray surface had a heterogeneous patchwork of dark gray and a somewhat lighter gray not readily discernible except by close observation. As the immersion time was increased, the proportion of light gray to the darker gray increased so that at the 3 minute immersion the coatings were distinctly a lighter gray.

✦ ✦ ✦

WITH the high phosphorus steels the coatings were distinctly lighter gray in color even at the shortest immersion time. Close observation showed the surface to have a 'woody', grainy or fibrous appearance even though the finish was smooth. With increased immersion time the grayness became slightly lighter in color and the coatings noticeably rougher, in most cases having a streaked appearance with prominent ridges. Even where the coatings turned bright at the 3 minute immersions, the surface was still rough and streaked.

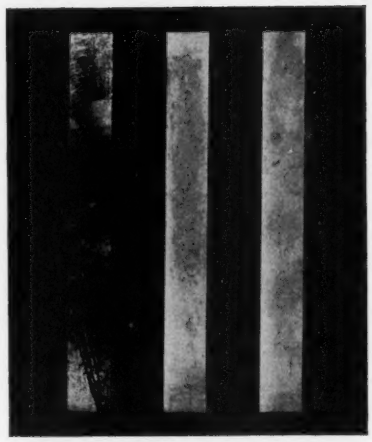

Fig. 33. Left to right, Samples B-1, P-1 and P-2, Series H, and G respectively, 30 second immersion. The P-1 and P-2 samples galvanized gray at the short immersion time. ✦ ✦ ✦

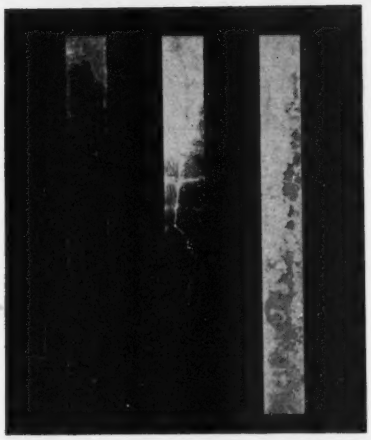

Fig. 34. Left to right, samples B-1, P-1 and P-2, Series H and G respectively, 180 second immersion. The P-1 sample had a strong tendency to galvanize bright as indicated. Sample P-2 was unchanged in its appearance. ✦ ✦

✦ ✦ ✦

IN summarizing briefly the effects of composition upon coating appearance it would appear that the presence of phosphorus and/or silicon are perhaps the most important factors to consider. It has been shown that at short immersion times, the presence in fairly large amounts of these elements, singly or in combination, produces gray coatings. With increased immersion time and in certain of the lower analysis ranges, bright coatings could be obtained. However, bright coatings are most readily obtained by using steel low in both of these elements.

✦ ✦ ✦

CONSIDERING the effects of the other elements it appears that their effect was nil at the short immersion time being influenced entirely by the presence of residual silicon and/or phosphorus. At the longer immersion time, the brightening effects counter-acting the influence of residual silicon was noted in a few cases.

✦ ✦ ✦

IN all cases, even when not specifically mentioned, the effect of increased immersion time caused increased roughness al-

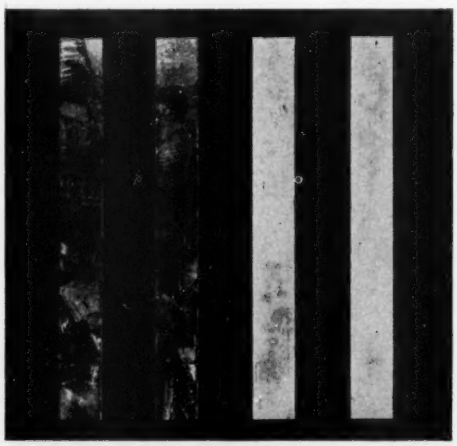

Fig. 35. Left to right, samples R-1, R-2, No. 8 Series F, and No. 10 Series A, 30 second immersion. The rimmed steels galvanized bright whereas the low-carbon steels which were silicon-killed, galvanized with a gray coating. ✦ ✦ ✦ ✦

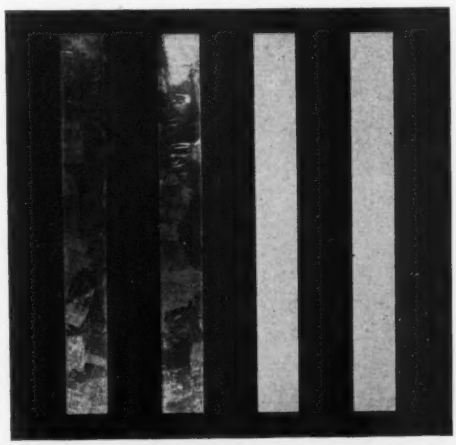

Fig. 36. Left to right, samples R-1, R-2, No. 8 Series F, and No. 10 Series A, 180 second immersion. Note that increased immersion time failed to change the appearance of any of the samples. ✦ ✦ ✦

Table XXIII
Series A

Base Composition: (Sample 10)		C .06	P .019	S .026	Mn .42	Cu .233	Si .106
Effects of Bend Tests							
Sample	**Analysis**	**Outside**			**Inside**		
10	.233% Cu	Perfect, no cracking or flaking, smooth			Cracked and flaked slightly		
1	.356% Cu	Perfect, no cracking or flaking, smooth			Cracked and flaked slightly		
2	.626% Cu	Perfect, no cracking or flaking, smooth			Cracked and flaked slightly		
10	.106% Si	Perfect, no cracking or flaking, smooth			Cracked and flaked slightly		
3	.220% Si	Perfect, no cracking or flaking, smooth			Had innumerable fine cracks and flakes, most of which could be rubbed off		
4	.348% Si	Perfect, no cracking or flaking, smooth			Had innumerable fine cracks and flakes, only part of which could be rubbed off		
5	.610% Si	Extremely fine cracks, but very adherent, could not be rubbed off			Extremely fine cracks, but very adherent, could not be rubbed off		
10	.48 % Mn	Perfect, no cracking or flaking, smooth			Cracked and flaked slightly		
6	.73 % Mn	Perfect, no cracking or flaking, smooth			Cracked and flaked slightly		
7	.85 % Mn	Perfect, no cracking or flaking, smooth			Cracked and flaked slightly		
10	.019% P	Perfect, no cracking or flaking, smooth			Cracked and flaked slightly		
8	.042% P	Extremely fine cracks, hard perceptible, would not rub off			Perfect, no cracking, smooth		
9	.086% P	Excessive cracking and flaking, large flakes very loose which dropped off completely			Completely flaked off with large cracks		

though in many cases it was hardly discernible. In other cases, notably in the case of the high phosphorus steels, the roughening effect due to increased immersion time was outstanding. In the case of high silicon steels the increase in roughness was practically negligible.

✦ ✦ ✦

Effect of Composition Upon Adherence

WHILE many galvanized products receive no further treatment, mechanical or otherwise, before they are put into service, many others do require some form of fabrication before they become finished products. In the latter instance it is absolutely essential that the galvanized coating adhere to the base metal.

✦ ✦ ✦

IN order to obtain some measure of coating adherence it was decided to subject the samples to a bend test and observe the effects. The bend tests were performed so as to give a free bend of 150° with a ¾" inside bending radius.

✦ ✦ ✦

SAMPLES subjected to the bend test were galvanized for 30 seconds since it probably more nearly represents commercial practice, and also because the heavier coatings obtained at longer immersion times being more brittle would make comparisons somewhat more difficult to evaluate.

✦ ✦ ✦

AT the outset it might be interesting to point out that it was intended to record only the flaking effects upon the outside bend, assuming that there would be a close relationship between the adherence on the outside and inside bends. Unfortunately, this did not prove to be the case and after a number of tests it was found necessary to record the bend effect upon both the inside and outside surfaces. Unfortunately also, this complicates matters considerably since it must be realized that in any case the results of bend tests are hardly quantitative in nature.

✦ ✦ ✦

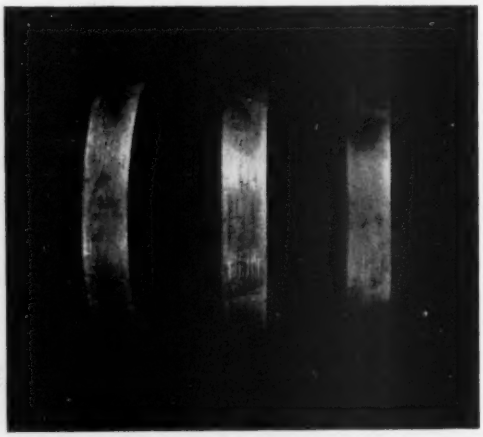

Fig. 37. Left to right, samples 10, 1 and 2, Series A, 30 second immersion, outside bend. All of the samples showed good outside bends. ✦ ✦ ✦

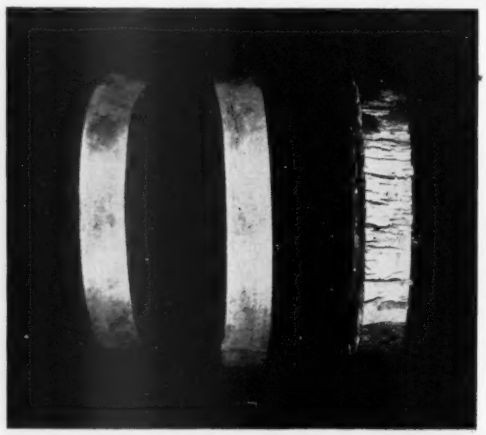

Fig. 38. Left to right, samples 10, 8 and 9, Series A, 30 second immersion, outside bend. Note the extremely poor coating adherence on the high-phosphorus sample. ✦

THE results of the bend tests are shown in Table XXIII.

✦ ✦ ✦

Series A

THE results of the bend tests indicated that neither copper nor manganese exerted any particularly noticeable effect; however, close examination indicated that increased copper decreases coating adherence very slightly. On the other hand it appeared that increased manganese improved coating adherence slightly. These effects were so slight as to be inconclusive and relatively unimportant.

✦ ✦ ✦

INCREASING the silicon content to .220 per cent caused much poorer coating adherence on the inside bend; however, increased amounts improved adherence considerably so that at .610 per cent silicon the coating adherence was better than the base sample.

✦ ✦ ✦

THE effect of phosphorus was somewhat erratic in that an increase to .040 per cent actually improved adherence which dropped off tremendously at .080 per cent.

✦ ✦ ✦

Series B

RESULTS of bend tests on the samples in this series are shown in Table XXIV. In this series the base sample had a smooth, bright spangled coat which had excellent bending properties. The addition of copper to this steel decreased coating adherence very slightly whereas the effect of increased manganese was nil.

✦ ✦ ✦

THE addition of silicon changes the coating appearance from bright and shiny to a dark gray with a considerable loss of coating adherence, particularly on the inside bend. As the silicon content is increased, however, the coating adherence is improved except for a slight decrease on the outside bend at the highest silicon content. This effect is consistent for the outside bend for the highest silicon coating samples of the respective groups in Series A and C.

✦ ✦ ✦

THE effect of phosphorus was erratic and inconsistent in that the highest phosphorus con-

Table XXIV
Series B

Base Composition: (Sample 10)		C .17	P .019	S .032	Mn .48	Cu .235	Si .015
Effects of Bend Tests							
Sample	**Analysis**	**Outside**			**Inside**		
10	.235% Cu	Perfect, no cracking or flaking			Perfect, no cracking or flaking		
1	.388% Cu	Perfect, no cracking or flaking			Perfect, although slightly rougher than sample 10		
2	.676% Cu	Nearly perfect, but cracked along one or two streaks and at the sharp corners			Very small cracks which impailed a roughness, coating very adherent however and could not be rubbed off		
10	.015% Si	Perfect, no cracking or flaking			Perfect, no cracking or flaking		
3	.132% Si	Extremely fine cracks but with no flaking along the sharp corners			Extremely fine cracking, but no flaking, coating very adherent		
4	.249% Si	Extremely fine cracks with some flaking along the sharp corners			Cracked and flaked, a good portion (about 50%) of which dropped off		
5	.508% Si	Small cracks with some large, the latter readily flaking off			Extremely fine cracking, but no flaking, coating very adherent		
10	.48 % Mn	Perfect, no cracking or flaking			Perfect, no cracking or flaking		
6	.73 % Mn	Perfect, no cracking or flaking			Perfect, no cracking or flaking		
7	.85 % Mn	Perfect, no cracking or flaking			Perfect, no cracking or flaking		
10	.019% P	Perfect, no cracking or flaking			Perfect, no cracking or flaking		
8	.045% P	Large cracks all over surface, large flakes most of which dropped off and remainder easily rubbed off			Perfect, with no cracking or flaking although the sample was heavily streaked and rough		
9	.084% P	Smaller cracks than above but nevertheless badly flaked part of which dropped off and the remainder easily rubbed off			Perfect, smooth, absolutely no sign of any kind of a crack		

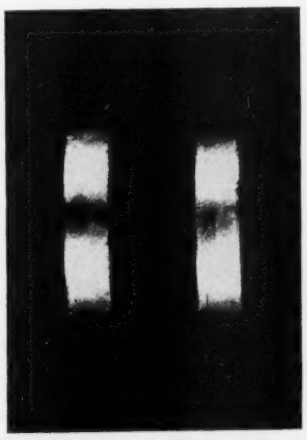

Fig. 39. Left to right, samples 10 and 2, Series B, 30 second immersion, outside bend. The effect of adding large amounts of copper was not apparent. ✦ ✦ ✦

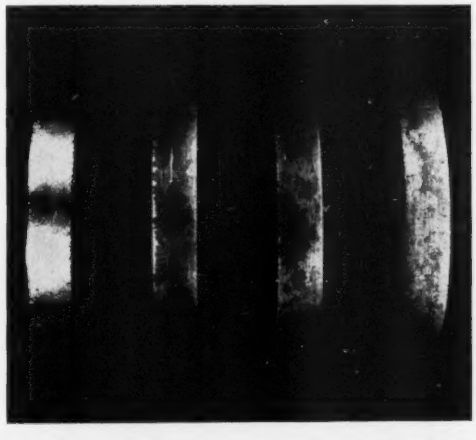

Fig. 40. Left to right, samples 10, 3, 4 and 5, Series B, 30 second immersion, outside bend. Note that the high silicon steel, sample 5, showed fine cracks although the coating was very adherent. ✦ ✦ ✦

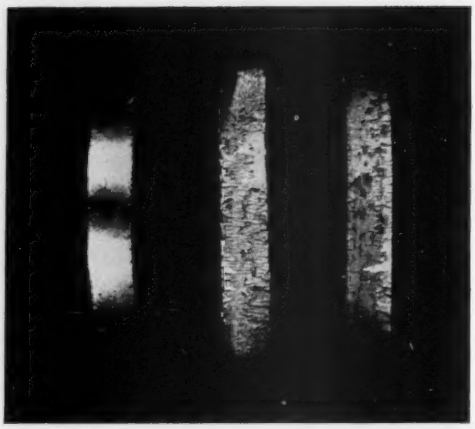

Fig. 41. Left to right, samples 10, 8 and 9, Series B, 30 second immersion, outside bend. Note the extremely poor adherence on both of the phosphorous steels. In this case the medium phosphorus steel did not have the benefit of any appreciable amount of residual silicon. ✦ ✦

Fig. 42. Left to right, samples 10, 3, 4 and 5, Series C, 30 second immersion, outside bend. The adherence on all samples was very good on the outside bend. Note however the very fine cracks on the high silicon sample; the coating would not rub off and was very adherent. ✦

taining sample was slightly better than the sample containing only .045 per cent. One thing is certain, however, that high phosphorus content decreases coating adherence tremendously as compared with steels containing very small amounts.

✦ ✦ ✦

Series C

THE effect of copper on coating adherence was more pronounced in this series than those preceding and indicated quite definitely that increased copper content has a detrimental effect.

✦ ✦ ✦

THE effect of manganese was practically negligible, close observation seemed to indicate very slight improvement but not definite enough to be conclusive.

✦ ✦ ✦

SINCE the base composition in this series contained silicon, increased silicon content improved coating adherence until the highest silicon content was reached at which point the outside bends showed fine cracks. This effect was also observed in Series A and B.

✦ ✦ ✦

INCREASED phosphorus decreases the coating adherence on silicon killed steels, the higher the phosphorus content the greater the amount of cracking and flaking. This effect checks the results observed in Series A which was also a silicon-killed steel. It does not check the results observed in Series B however, that base composition being a semi-killed steel with but a trace of silicon. However, in any case, the ill effects of a high phosphorus content on coating adherence was clearly indicated.

✦ ✦ ✦

Series E

THE effect of copper in this series was hardly noticeable, having a slight detrimental effect on coating adherence. This checks data obtained in Series A, B and C. Since copper has a negligible effect its effect in the various combinations contemplated for this series does not warrant a detailed discussion. Various combinations of steels showing the effect of copper are: 12 and 3, 1 and 8, 4 and 5, 12 and 2, 1 and 10, 7 and 11.

✦ ✦ ✦

THE effect of increased silicon in the amount shown was not obvious. The very fine cracks observed on the outside and inside bends would probably indicate a perceptible decrease in coating adherence. The steels showing the effect of silicon are: 2 and 5, 12 and 4, 3 and 5, and, 12 and 5.

✦ ✦ ✦

THE effect of increased phosphorus was the same as noted

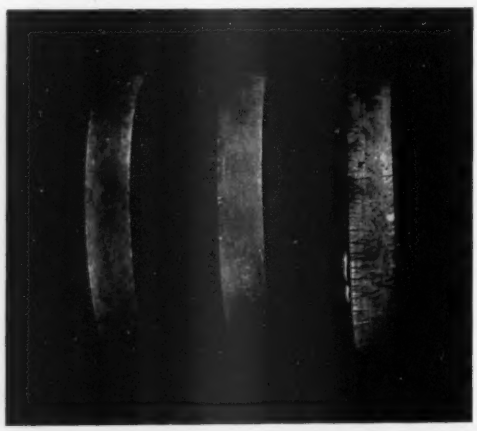

Fig. 43. Left to right, samples 10, 8 and 9, Series C, 30 second immersion, outside bend. Note that the bend of the medium phosphorus steel is good, being aided by a high residual silicon content. The coating adherence on the high phosphorus steel is very poor. ✦ ✦

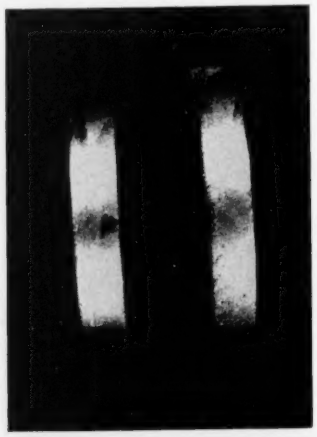

Fig. 44. Left to right, samples 12 and 2, Series E, 30 second immersion, outside bend. Increasing the copper content seemed to have no effect. While in many cases it seemed that copper was slightly detrimental, the results were not conclusive. ✦ ✦

in previous tests, namely, that the coating adherence on the outside bends is decreased to nil. For

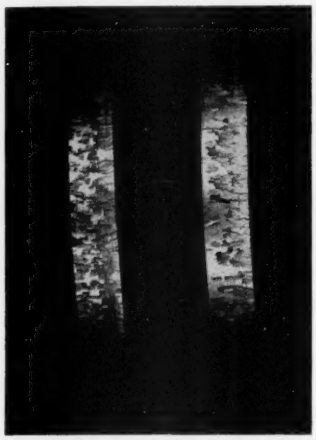

Fig. 45. Left to right, samples 10 and 1, Series E, 30 second immersion, outside bend. Both samples were high in phosphorus, sample 10 also having high copper content. The effect of the increased copper content was not apparent. ✦

some reason or other however, the coatings, in most cases, on the inside bend remain intact. Occasionally a large area will flake out in a single piece and the remainder remain intact without even showing the sign of a crack. It is evident that the nature of the coating on this class of steels is such as to resist this type of stress. Steels showing this effect in this series are 12 and 10, 2 and 10, 12 and 1, 3 and 8.

✦ ✦ ✦

THE high silicon, high phosphorus steels had good coating adherence on both the outside and inside bends which indicates that silicon is probably the dominating factor in such a combination.

✦ ✦ ✦

Series F

THE results of this series are shown in Table XXVII from which it appears that increasing the carbon content on a silicon-killed steel causes a decrease in coating adherence, especially on the inside bend. The same general results were observed in the case of titanium and aluminum.

✦ ✦ ✦

Series G

THE effect of adding silicon to a steel already high in silicon (and phosphorus) had no marked effect other than to cause a hardly perceptible decrease in coating adherence as observed on the inside bend. The results of this silicon addition are shown in Table XXVIII.

Table XXV
Series C

Base Composition: (Sample 10)		C .32	P .017	S .027	Mn .50	Cu .191	Si .127
		Effects of Bend Tests					
Sample	**Analysis**	**Outside**			**Inside**		
10	.191% Cu	Perfect, very minute cracks but no flaking, coating very adherent and smooth			Very small cracks which flaked off in a few places		
1	.358% Cu	Perfect, very minute cracks but no flaking, coating very adherent and smooth			Excessive cracking and flaking, practically all of which dropped off		
2	.600% Cu	Perfect, very minute cracks but no flaking, coating very adherent and smooth			Excessive cracking and flaking, practically all of which dropped off		
10	.127% Si	Perfect, very minute cracks but no flaking, coating very adherent and smooth			Very small cracks which flaked off in a few places		
3	.248% Si	Perfect, no fine cracks observed, satin smooth			Small cracks which flaked off in a number of places		
4	.357% Si	Perfect, no fine cracks observed, satin smooth			Extremely small cracks, causing a slight roughness, would not rub off—a better bend test than sample 3 or 10		
5	.625% Si	Extremely small cracks causing a slight roughness, however would not flake when rubbed			Extremely small cracks, causing a slight roughness, would not rub off—a better bend test than sample 3 or 10		
10	.50% Mn	Perfect, very minute cracks but no flaking, coating very adherent and smooth			Very small cracks which flaked off in a few places		
6	.69% Mn	Perfect, very minute cracks but no flaking, coating very adherent and smooth			Very small cracks which flaked off in a few places		
7	.89% Mn	Perfect, very minute cracks but no flaking, coating very adherent and smooth			Very small cracks which flaked off in a few places		
10	.017% P	Perfect, very minute cracks but no flaking, coating very adherent and smooth			Very small cracks which flaked off in a few places		
8	.040% P	Extremely fine cracks which rubbed off in a few minute places			Badly cracked and excessively flaked, most of which dropped off or was easily rubbed off		
9	.080% P	Small cracks and excessively flaked most of which was easily rubbed off			Completely flaked off, came off in large pieces with but little cracking effect		

✦ ✦ ✦

Series H

THE results of bends tests of the steels in this series are shown in Table XXIX. The observations to be made on steels B-1, B-2, B-3, B-4, B-5 are in general the same as those made on similar steels in preceding series.

✦ ✦ ✦

STEELS low in silicon and phosphorus galvanize with bright coatings and ordinarily have good coating adherence. In this regard however exception must be cited in the case of the rimmed steels R-1 and R-2 which had surprisingly poor coating adherence considering

the type of coating. It seems somewhat unusual that the semi-killed steels such as sample 10, Series B; sample 14, Series D; sample 12, Series E; and B-1, Series H, should have such superior bending properties.

Table XXVI
Series E

Base Composition:	C	P	S	Mn	Cu	Si
Heat 2959 (Sample 12)	.11	.015	.028	.37	.009	.175

Effects of Bend Tests

Sample	Outside	Inside
12	Perfect, no cracking or flaking	Perfect, no cracking or flaking
1	Badly cracked and almost completely flaked off	Perfect, no cracking or flaking
2	Small cracks with a little flaking off near the corners when rubbed	Nearly perfect, very fine cracks but no flaking, was slightly rougher than the inside of sample 12, very adherent
3	Small cracks, some of which could be rubbed off	Increased roughness but coating was very adherent
4	Extremely fine cracks hardly perceptible, smooth and very adherent	Extremely fine cracks hardly perceptible, smooth and very adherent
5	Extremely fine cracks hardly perceptible, smooth and very adherent	Extremely fine cracks hardly perceptible, smooth and very adherent
6	Extremely fine cracks hardly perceptible, smooth and very adherent	Extremely fine cracks hardly perceptible, smooth and very adherent
7	Perfect, no cracks, smooth	Perfect, no cracks, smooth
8	Badly cracked and almost completely flaked off	Perfect, no cracking or flaking
9	Extremely fine cracks over entire surface with a slight amount of flaking at the corners	Perfect, no cracking, smooth
10	Badly cracked and almost completely flaked off	One large patch flaked off, there were no cracks on any of the remainder of the inside
10 S	Perfect, no cracking or flaking	Perfect, no cracking or flaking
11	Fine cracks over entire surface with a slight amount of flaking, especially near the corners	Perfect, no cracks, smooth

Table XXVIII
Series G

Base Composition:	C	P	S	Mn	Cu	Si
(Sample P-1)	.10	.099	.035	.39	.292	.218

Effect of Bend Tests

Sample	Analysis	Outside	Inside
P-1	.218% Si	Perfect, no cracks, smooth	Perfect, no cracks, smooth
P-2	.500% Si	Perfect, no cracks, smooth	Extremely minute cracks barely discernible, coating very adherent

✦ ✦ ✦

STEEL S-1, high in sulphur exhibited the bending characteristics of a comparatively low silicon steel the sulphur content apparently having no noticeable effect.

✦ ✦ ✦

Summary of Bend Tests

IN summarizing the effects of composition on coating adherence as revealed by a simple bend test the results would have been rather clear cut and concise had only the appearance of the outside bend been considered as was first contemplated. However, it is needless to point out that if serious cracking and flaking effects occur on the inside bend as well, then certainly it too must be considered.

✦ ✦ ✦

UNFORTUNATELY the results of observations on the inside bend were none too consistent and in the case of the phosphorus-silicon quite unpredictable. Nevertheless certain conclusions can be derived which are listed as follows:

✦ ✦ ✦

(1) Effect of manganese variations were without appreciable effect and hence can be considered as unimportant.

(2) Copper exerts a slight though positive detrimental effect upon coating adherence not of sufficient import however to be a factor of prime importance.

(3) Silicon plays an important role in affecting coating adherence because in the first place its presence or absence determines whether or not a coating will be bright and spangled or a dark gray. Bright spangled coatings ordinarily have good coating adherence whereas the gray type coating may or may not have good coating adherence depending upon the amount of silicon present (and also the amount of phosphorus). Assuming low phosphorus content, then silicon steels will in all cases exhibit perfect outside bends and in most cases good inside bends. However in certain of the lower ranges the coating adherence on the inside bend ranges from fair to poor, this range varying somewhat and in some steels entirely absent.

(4) The effect of phosphorus, like silicon, exerts a powerful effect upon coating adherence because it too determines whether or not a coating will be bright and spangled or gray. A gray coating produced by the presence of phosphorus has notoriously poor coating adherence on the outside bends, in fact the

coating in practically all cases flakes off completely and drops off by its own weight or is easily brushed off by hand. For some reason the coatings remain intact on the inside bends and it is quite possible that the nature of the test specimen is a determining factor, at any rate it is a fact that such coatings are extremely brittle and readily flake or chip off when subjected to simple stresses.

It is very important to note however that the ill effects attributed above to phosphorus apply only when the amount is high. The dividing line above which the coating adherence is very poor seems to be in the region of from 0.040 - 0.050 per cent depending upon the silicon content of the steel. In semi-killed steels the lower limit would seem to apply whereas in silicon-killed steels with from .12 to .18 per cent silicon the upper limit would apply, in other words, silicon retards the ill effects of phosphorus somewhat so that larger amounts must be present before serious loss of coating adherence occurs.

(5) In the case of high phosphorus-silicon combinations the results are somewhat erratic in regard to the possible effect upon the inside bend. With the silicon content over .20 - .25 per cent the outside bends will always exhibit perfect adherence, however the inside bends are not improved to a satisfactory state until much higher silicon contents are attained.

✦ ✦ ✦

Table XXVII

Series F

Base Composition:	C	P	S	Mn	Cu	Si
Heat 2178 (Sample 8)	.05	.011	.026	.45	.229	.120

Effects of Bend Tests

Sample	Analysis	Outside	Inside
8	.05% C	Perfect, no cracks, smooth	Cracked, with a large area completely flaked off
1	.20% C	Perfect, no cracks, smooth	Practically all of inside bend flaked off
2	.35% C	Nearly perfect, flaked slightly at the corners	Completely flaked off
8	.000% Ti	Perfect, no cracks, smooth	Cracked, with a large area completely flaked off
3	.042% Ti	Nearly perfect, flaked slightly at the corners	Completely flaked off
4	.100% Ti	Nearly perfect, flaked slightly at the corners	Completely flaked off
5	.169% Ti	Nearly perfect, flaked slightly at the corners	Completely flaked off
8	Trace Al	Perfect, no cracks, smooth	Cracked, with a large area completely flaked off
6	.145% Al	Nearly perfect, flaked slightly at the corners	Badly cracked and flaked, easily rubbed off
7	.303% Al	Extremely fine cracks over entire surface which flaked off in a few places, especially at the corners	Badly cracked and flaked, easily rubbed off

IN conclusion with reference to the coating adherence the author wishes to emphasize the facts that there are many factors influencing coating adherence in addition to composition. Some of these factors include: (1) Type and size of section, (2) nature and severity of stress, (3) speed of bend or application of stress, (4) time of immersion, (5) temperature of spelter, (6) rate of cooling, (7) type of wipe if any, (8) general galvanizing technique including pickling and fluxing practice.

FOR the reasons mentioned above we do not claim the results of these bends tests to be quantitative in nature but rather qualitative in that one can expect certain general effects to concur depending upon the type of steel galvanized.

Fig. 46. Left to right, samples B-1, B-2, B-3 and B-4, Series H, 30 second immersion, outside bend. In sample B-3 we observe that when the phosphorus content is very high a low residual silicon is not sufficient to give good adherence; sample B-4 demonstrates that a higher silicon content is necessary to overcome the effect of phosphorus. ✦

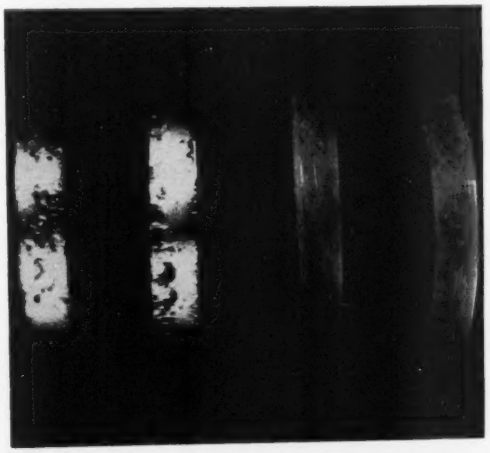

Fig. 47. Left to right, samples R-1, R-2, No. 8, Series F, and No. 10 Series A, 30 second immersion, outside bend. There was considerable cracking on the rimmed steel sample, although there was no flaking. In this respect, the rimmed steels were inferior to semi-killed low-carbon, low-phosphorus steels. The low-carbon, silicon killed steels showed good outside bends. ✦ ✦ ✦ ✦

Table XXIX
Series H

Individual Heats

Effects of Bend Tests

Sample	Outside	Inside
B-1	Perfect, no cracks	Perfect, although slightly roughened
B-2	Badly cracked and mostly flaked off	Completely flaked off
B-3	Completely flaked off	Completely flaked off
B-4	Perfect, no cracks	Innumerable small cracks and flakes, most of which were easily rubbed off by hand
B-5	Perfect, no cracks	Innumerable small cracks and flakes, part of which were easily rubbed off
R-1	Badly cracked and partly flaked off, flakes had a tendency to stick fairly tight however	Almost perfect, fine cracks which imparted a roughness, would not rub off, coating very adherent
R-2	Similar to R-1 alone but cracked more on the edges and flaked worse, flakes rubbed off easier—with R-1 the cracking was confined mostly to the middle rather than the corners	Similar to R-1 but a little worse, had a few small flakes along one edge which would not rub off however
S-1	Extremely fine cracks, hardly perceptible, flaked off slightly near the sharp corners	Badly cracked and flaked, about ½ of which was easily rubbed off by hand

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PART II
Will Be Published in the December Issue of Wire and Wire Products.

Mordica Memorial Lecturer For 1941

THE highest honor which can be paid by the Wire Association to any member, is to be selected as the Mordica Memorial Lecturer.

✦ ✦ ✦

THE first of these lectures was presented by **Dr. S. A. Braley,** Mellon Institute of Industrial Research in 1939 on the subject of "A Correlation of the Factors and Effects of Cold Drawing of Wire Rods".

✦ ✦ ✦

THE second lecture was presented this year by **Mr. B. L. McCarthy,** Chief Metallurgist, Wickwire Spencer Steel Company, Buffalo, New York, on the subject of "The Use of Plane Polarized Light and Sensitive Tint Illumination in the Analysis of the Microstructure of Steel".

FOR 1941, the Board of Directors of the Association unanimously selected **Mr. Kenneth B. Lewis,** consulting wire mill engineer, of Worcester, Mass., for this honor.

✦ ✦ ✦

THE selection was made on the basis of Mr. Lewis' eminently professional attainments, together with his thorough knowledge of every phase of the wire industry.

SLEEPER & HARTLEY INC.

Worcester, Mass.

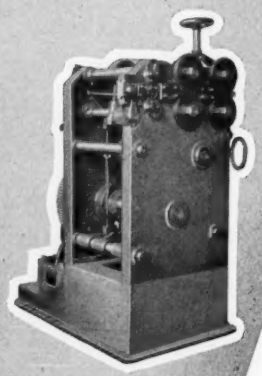
Built the FIRST Automatic Spring-Coiling Machine in 1911

(A No. 2 Series 254
50 Springs per minute)

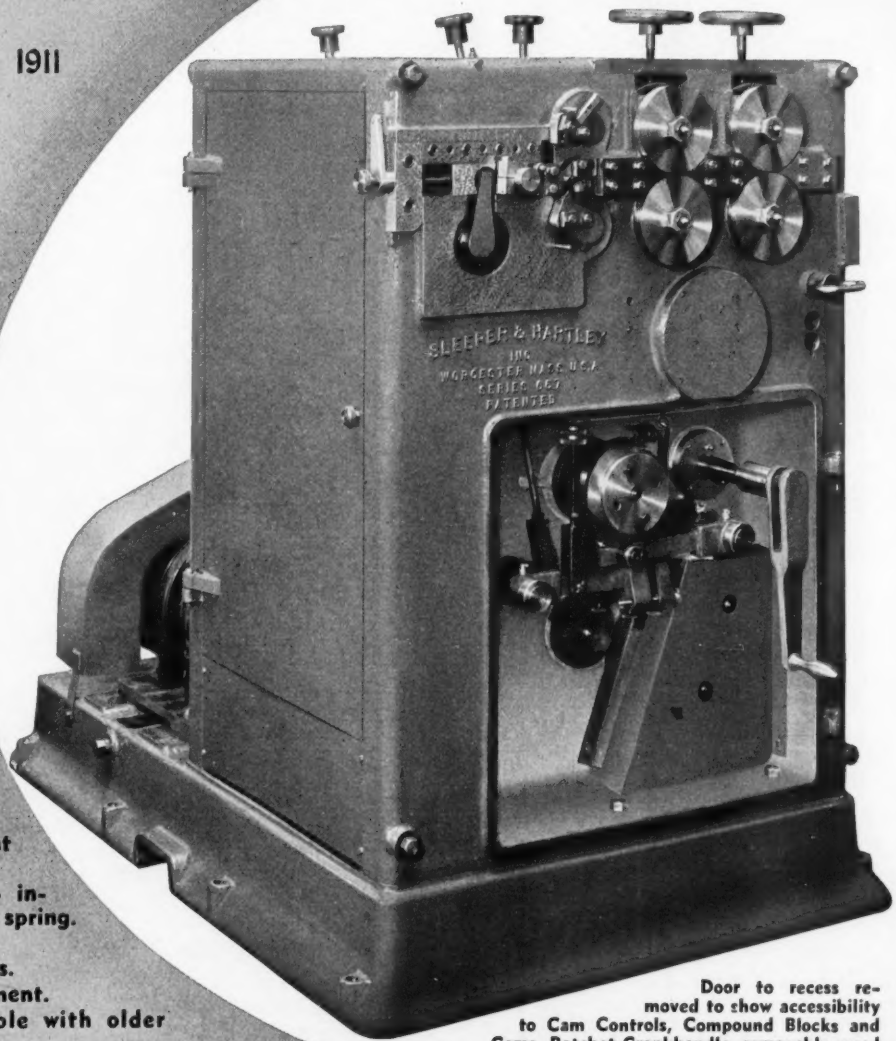
The NEW-IMPROVED No. 2 Series 667 Arrived in 1938

(Production from 17 to 110 Springs per minute)

1911



1938



Door to recess removed to show accessibility to Cam Controls, Compound Blocks and Cams. Ratchet Crankhandle, removable, used for set-up purposes only.

In the spring-coiling machine field there are 14 Models from which to select (including Series 254) varying in price and capacity.

1938 DISTINCTIVE FEATURES

- Pitch and Diameter Cams and Compound Levers are accessibly located in the recess of front housing.
- Auxiliary Gearing to increase wire length per spring.
- Alloy Steel Tools.
- Anti-friction Bearings.
- Simplicity of Adjustment.
- Tools interchangeable with older models.
- Cams may be Shaped and timed on the Cam Hub and the entire unit removed.
- Morse Free-wheeling and Recoil Clutches.

Steel Quality and Labor Relations

By C. M. White,

Vice President in Charge of Operations,
Republic Steel Corporation, Cleveland, Ohio

An address delivered at the Annual Convention of the Wire Association at Cleveland, Ohio, October 23, 1940.

WHILE we sit here comfortably in this hotel, the Germans are blasting England to pieces and the English are blasting Germany to pieces. The Japanese are bombing the Chinese. And the English and the Italians are trading blows in Africa.

✦ ✦ ✦

HOW soon may we, too, have to face the possibility of war?

✦ ✦ ✦

THERE is no use dodging this question. No matter what we may be thinking or talking about, it is always in the back of our minds. So we may as well drag it right out into the open and face it.

✦ ✦ ✦

THE United States, right now, just as rapidly as possible, must build up an Army and Navy and an air force so strong and so powerful that we can stop cold any possible attempt at invasion of this country either from the east or the west. And it is from exactly that standpoint that I want to talk to you today on the subject which has been assigned to me — Steel Quality and Labor Relations.

✦ ✦ ✦

THE last war caught the steel industry right in the middle of a period of basic research and development. In those days, research work in our laboratories had shown many possibilities which had not yet been perfected. And what was true with steel was equally true with respect to airplanes, tanks and many other items of war and defense equipment.

✦ ✦ ✦

IN the last war, for instance, airplanes were not a major factor. But the experience of 1916 to 1918 gave some indication as to what airplanes might be able to do, if airplane engineering and steel metallurgy could keep on developing side by side.

✦ ✦ ✦

IN the years following the war, steel research continued. It ran squarely into the great depression. But all through that period research men in the steel laboratories of this country kept at work. They made amazing progress.

✦ ✦ ✦

BY 1935 we saw perfected and put on the market a whole range of steel alloys which were for the first time made available for broad industrial purposes in quantities and at prices which made their use practicable.

✦ ✦ ✦

BY way of illustration—one example of the steels which came out of laboratories at this time was stainless steel strip suitable for stamping and forming operations. Not only straight chromium stainless — there was also produced chromium-nickel steel, and chromium-nickel steel made still more useful by the addition of molybdenum, titanium and columbium.

✦ ✦ ✦

THIS last element, known to the British as niobium, was only a curiosity just a few years ago.

✦ ✦ ✦

TODAY we are adding tellurium to stainless for improved machinability. We make it with silver for high corrosion resistance.

✦ ✦ ✦

I CITE these examples simply to give you some idea about what is going on in this direction—and frankly, we see literally no limit to alloy steel possibilities.

✦ ✦ ✦

I HAPPEN to be familiar with this subject because Republic, from the very beginning, was a pioneer in alloy steels, especially in the field of stainless steel.

✦ ✦ ✦

DURING the past five years we have had countless practical demonstrations of the new uses of these high-quality alloy steels.

✦ ✦ ✦

FOR instance, the development of modern high-speed streamlined trains has been made possible only because of the availability of stainless steel and other weight-reducing alloys. This has been equally true with respect to many new developments in the automotive and aircraft industries. New alloy steels have greatly reduced the pound per horsepower ratio required in aircraft engines and have prolonged the life of the motor.

✦ ✦ ✦

IN the field of food processing and marketing, corrosion-resistant alloys have made possible a whole range of new developments.

✦ ✦ ✦

CORROSION - RESISTANT alloys have also been contributing to better casing and longer lived equipment in the oil industry. Improved steels and modern treatments have made it possible to drill and operate oil wells at far greater depths than were considered a possibility until recently. Tubing for today's high-pressure boilers and turbines is an additional example of development made possible by the creation of better steels for special uses. The 5% chrome-molybdenum steel tube is practically standard equip-

ment today, superseding the carbon steel tube of only a few years ago.

✦ ✦ ✦

IN fact practically every division of industry has benefited from new alloy steels specially adapted to special purposes.

✦ ✦ ✦

THIS has by no means been due entirely to steel metallurgy and laboratory experimentation. A great deal of it has been due to the development and practical application of better methods of production.

✦ ✦ ✦

AN outstanding example is the building of better and larger electric furnaces. Republic, for instance, has just installed its fourth 50-ton electric furnace for the production of high-quality special alloy steels.

✦ ✦ ✦

THE best known illustration of improvement in steel-making equipment and processes is of course the continuous strip mill. As everyone knows, the continuous mill makes possible increased production of strip at far lower costs. But this is by no means the only result. The fact is that strip steel made by the continuous mill process has far more uniform drawing qualities and a higher finish than was even remotely possible on the old hand mills.

✦ ✦ ✦

ALL of you in the wire industry are familiar from your own personal experience with the steadily improving quality of steel in recent years.

✦ ✦ ✦

FOR example, cold headed cap screws are today being made directly from wire, headed, trimmed, pointed, and threaded on one machine.

✦ ✦ ✦

STAINLESS steel wire for aircraft cables is an important item today. This has been made possible only because of consistent research development and equipment improvement in the steel industry.

✦ ✦ ✦

NOT so many years ago automotive valve spring wire of the finest quality could be obtained only from Norway. Today that wire is being made successfully in the United States.

✦ ✦ ✦

I DON'T have to tell any one of you about the increased productivity of modern wire-drawing equipment by comparison to that of a few years ago.

✦ ✦ ✦

SINCE the 1920s the development of the tungsten carbide die has cut die costs by approximately two-thirds and made it possible to speed up wire-drawing to an amazing extent.

✦ ✦ ✦

IN 1915 a die might finish a 300-pound bundle within commercial tolerances — but beyond that its accuracy was uncertain. Today a die frequently does a good job for more than 40,000 pounds of steel wire.

✦ ✦ ✦

WHY were steel companies so tremendously concerned with the development of new and better quality steels? Why were they so greatly concerned with the installation of new and better equipment for the production of these steels?

✦ ✦ ✦

THE reason was that the steel-makers of this country firmly believed that steels of higher quality, steels especially adapted to special purposes, would lead to new uses for steel, and new markets for steel, which would prove greater than any markets that had thus far been known in the entire history of the country.

✦ ✦ ✦

I AM convinced that the nation's steel-makers were absolutely right in this expectation. The events of the last few years have proved it. But suddenly, right in the middle of this proof, along came war in Europe and the immediate need for re-arming this country for national defense.

✦ ✦ ✦

IT is fortunate indeed that the steel companies of this country spent the money, the time, and the effort which they did in developing better steels for more of the peace-time purposes of this country. For in so doing they developed the very steels, and the equipment to make them, which are so urgently needed for purposes of national defense.

✦ ✦ ✦

THE development of chrome-nickel-molybdenum steels for aircraft engine construction designed originally for peace-time purposes has proved all-important for defense.

✦ ✦ ✦

THERE is hardly a single item of national defense equipment which does not require steel.

✦ ✦ ✦

THE range of specifications of steel for national defense is as broad, or even broader, than the range of specifications for peace-time products.

✦ ✦ ✦

IN national defense production there can be no guesses as to the capacity of steels to live up to the demands made upon them.

✦ ✦ ✦

FOR instance—in a gun firing a long-range shell it is necessary to concentrate a terrific amount of power in a very small area. This requires the use of the strongest, toughest and most completely corrosion-resistant steel that can possibly be made, in order to hold up against the tremendous punishment which it has to take, in many cases, many times per minute. There simply cannot be any doubts about that steel. If that steel fails, our defense fails.

✦ ✦ ✦

IN engineering design the factor of safety is ordinarily computed as three or four times the estimated load. For instance, a machine or a structure that is supposed to carry a maximum computed load of 1000 pounds is usually built heavily enough to carry a load of 3,000 to 4,000 pounds. In a case where public safety is involved, the safety factor is figured at an even higher rate. An elevator cable, for example, expected under normal conditions to carry a load of 5 tons, is in fact made heavy enough to carry a possible load of 60 tons.

✦ ✦ ✦

BUT in designing military equipment it is absolutely impossible to multiply the safety factor in this way. The reason is, of course, that any increase in the

safety factor means more weight —and weight can be added only at the expense of mobility and swift performance.

✦ ✦ ✦

ANY added weight to the structural parts of an airplane, for example, means a reduction in the number of guns and bombs which it can carry. Adding weight to a tank means slower speed and makes it less capable of swift maneuvers.

✦ ✦ ✦

THEREFORE in designing planes, tanks, etc., the factor of safety simply cannot be handled by arbitrarily increasing the amount of steel used. It can only be handled by making absolutely certain of the **quality** of the steel used.

✦ ✦ ✦

FOR instance—an amazing story is told in connection with the British tanks which successfully held off the Germans at Dunkerque while the British force were escaping across the channel. These tanks were designed to have the least possible weight required to stand up under fire. In fact they were so closely engineered that plate would be stopped by the last projectiles hitting their armor ⅛ inch of steel.

✦ ✦ ✦

THE men inside the tanks said, "It was hell to watch bulges forming on the inside of the tank wherever we got hit and to watch these bulges turn red-hot under the impact — but it was damn comforting to know that they couldn't quite get through."

✦ ✦ ✦

THE fact is that the construction of armor-protected land fighting equipment and the use of armor on aircraft have practically revolutionized modern warfare. It is simply another chapter in the age-old story of the race between the capacity of the projectile to penetrate and the ability of armor to resist such penetration.

✦ ✦ ✦

SO, from the standpoint of quality, the job before the steel industry today in preparing for national defense is tougher than any job which has ever been put up to us before. If this country should actually have to face war, we must give our boys the very finest equipment which it is possible for mankind to produce. This means that the steel industry must turn out steels of such a high, uniform quality that the safety factor can be figured to a minimum and still be **in fact a safety factor.**

✦ ✦ ✦

THE Army and the Navy must know absolutely that they can figure weight down to the lowest possible degree, and at the same time be assured that the steels which they use will give them the full measure of protection demanded by their specifications.

✦ ✦ ✦

THANKS to the research, the metallurgy, and the improvement in steel-making processes which have been developed in recent years, I say without any reservations whatever that the steel industry of this country can do **exactly** that job.

✦ ✦ ✦

BUT it takes more than research, metallurgy, and equipment to make steel.

✦ ✦ ✦

ABOVE all, it takes men to make steel — men who know their business as steel-makers, men who have a pride in their work and who believe they are getting a square deal from their country and from their employers. And this brings us directly into the subject of labor relations.

✦ ✦ ✦

I WANT to tell you a few things today about the men who are making the country's steel. I know them well, because, you might say, I was practically raised with them. I have been working with them all my working life. And I want to tell you that in my opinion they are mighty good citizens, and if this country should ever actually be threatened by any foreign power, you can bet your bottom dollar that the men in the steel plants of this country will go to work, hammer and tongs, without a single reservation, for the defense of these United States.

✦ ✦ ✦

THIS country can be defended only with steel. Steel is of necessity the first line of national defense. And the men who make steel stand today over 500,000 strong as an army already mobilized for the protection of our democratic form of government.

✦ ✦ ✦

THESE men who make steel are proud of their work and proud of their jobs. They know very well that they can do the job that has to be done better than it can be done by anybody else.

✦ ✦ ✦

STEEL production isn't just a matter of employment. Steel production is a matter of tradition and skill. It takes men who know the art of making steel.

✦ ✦ ✦

TAKE, as just one example, an open hearth furnace. Steel metallurgists have studied this operation most carefully. Operating men have also studied it most carefully. And yet, to this day, the successful operation of an open hearth furnace depends upon the instinct and the experience of the men actually on the job. It depends upon the observation and the judgment and the skill of men who know steel and live steel.

✦ ✦ ✦

THERE is no scientific instrument yet developed which will tell the melter exactly what to do. That is something that he simply has to know. And that's why it takes from seven to ten years for a melter to learn his profession.

✦ ✦ ✦

THERE is no scientific instrument that will do the job for a heater, or a roller, or a wire drawer. So there you are. To make steel and good steel, it takes skill, experience and judgment. And men who have skill, experience and judgment are usually individualists with rather distinct ideas as to the things which they believe they are entitled to.

✦ ✦ ✦

WE all think we are pretty good in our own line. So do they. We all want certain things from our employers and our country. So do they. They want just the same kind of a deal that we want.

✦ ✦ ✦

THEY want fair wages. I would define a fair wage as the best wage that a company can pay and

(*Please turn to Page 702*)

Wire Association Convention High Lights

Sandelin awarded 1940 Wire Association Medal. ✦ ✦ Meetings noteworthy for new and interesting topics presented and discussed. ✦ ✦ ✦

THE outstanding features of the Tenth Annual Convention of the Wire Association, held at Cleveland, Ohio, October 21st to 25th, may be said to be the growth in attendance, with particular reference to the Non-Ferrous Division of the Association.

✦ ✦ ✦

AMONG the highlights were the Mordica Memorial Lecture delivered by **Mr. B. L. McCarthy,** Chief Metallurgist, Wickwire Spencer Steel Company, Buffalo, New York, on the subject of "The Use of Plane Polarized Light and Sensitive Tint Illumination in the Analysis of the Microstructure of Steel", and the paper by **Mr. R. W. Sandelin** of the Atlantic Steel Company, Atlanta, Ga., entitled "Galvanizing Characteristics of Different Types of Steel" which received the Wire Association Medal Award for "the most meritorious paper written by a member of the Association during the year".

✦ ✦ ✦

AS usual, the Wire Association luncheon at which **Mr. C. M. White,** Vice-President of Operations, Republic Steel Corporation, was the speaker, was well attended and the Smoker-Dinner had a record crowd.

✦ ✦ ✦

THE initial meeting with, **Mr. F. A. Westphal,** Superintendent of Wire Mills, Sheffield Steel Corporation, past president of the Wire Association, presiding, was opened at 2:30 P. M. on October 21, 1940 and was well attended.

✦ ✦ ✦

THREE outstanding papers and discussions were presented. By referring to the subsequent publications on the discussions to be published in the January, 1941 issue of Wire and Wire Products and papers given at this meeting, the membership will be enabled to get details not given in this review of the meeting. There were three papers and they are as follows: (1) Tungsten Carbide Dies & Tools, by **James R. Longwell,** Chief Engineer of the Carboloy Co., Inc., who in his well known manner, very ably presented his subject and emphasized particularly the making of shaped Tungsten Carbide Dies. He went into great detail in showing stereoptican slides the operations along with the machine tools for making these shaped dies from the rough cored nib through to the fully finished polished die to correct dimensions and ready for operation. Mr. Longwell gave a constructive criticism that in his opinion superintendents and department heads were neglecting and lacking in proper supervision of their respective die rules. Wire mills realize that Tungston Carbide can take a terrific beating and the tendency has been to relax on meticulous details in the making of dies that consequently results in many die rooms having in their racks imperfect dies that subsequently give short expectancy on tonnage with a resultant reaction on quality for surface of wire. Mr. Longwell went into the economics pertaining to his subject and H. B. Clark widely commented that later was answered by Mr. Longwell in a slight rebuttal.

✦ ✦ ✦

(2) MR. J. A. DOYLE, Vice President of the W. S. Rockwell Company, of New York City, presented as his paper "Recent Developments in Heating Copper Wire Bars." We all recall Mr. Doyle's paper at the Detroit convention in 1938, on "Heating Copper Wire Bars," at which time the Board of Directors in considering the annual Medal Awards, gave Mr. Doyle honorable mention. The paper this year was really a progressive supplement to his excellent paper of 1938, and true Celtic humor was interwoven in the author's paper to emphasize and drive home his points. The subsequent publication of his paper should be looked forward to by those who listened to his presentation which gave a broad perspective of the heating application of copper from the poling through subsequent operations to copper ready for fabrication. The close control in application of heating copper was emphasized by the statement "The heater is a more important man on the crew than the roller."

✦ ✦ ✦

(3) MR. J. P. ZUR, Engineer of the Trauwood Engineering Co., Cleveland, Ohio, presented as his paper "Electric Patenting, Tempering and Annealing of Steel Wire." This subject covered a decidedly new feature in the Wire Industry. The author presented many charts and pertinent data by stereoptican slides that demonstrated the superiority of high carbon wire made from an electric patented stock compared with high carbon wire made from the same coil of stock by the orthodox Furnace Patenting. The author stated that the electrical contacts on hot rolled rods and wire drawn to a patenting size responded the same, or in other words, the sur-

face scale made no difference. The author furthermore stated that in building an electrical patenting unit, that electrical capacity is based on so many tons per hour that correct patenting can be accomplished, which should be a key and ascertain the size of a unit to be built.

✦ ✦ ✦

IN **Mr. Sandelin's** paper, he pointed out that silicon and phosphorus are important to consider as far as the appearance of galvanizing coating is concerned. Steel with a silicon content of 0.20 to 0.30 per cent tends to impart a bright coating especially if a reasonably long immersion in the zinc is followed. If phosphorus is high enough, it will turn the steel gray. If above 0.40 per cent, it imparts a grain effect on the steel. Titanium, he stated, tends to impart a bright coat.

✦ ✦ ✦

REACTIVE drawing methods are applicable to most wire mills in the opinion of **H. A. Stringfellow,** Worcester, Mass. If the product is of a highly competitive nature and costs are paramount, the speaker stated, then reactive drawing will lessen the cost of dies, lubricant, power and heat treatment and increase production. For airplane construction, a superior high strain airplane wire can be produced reactively at a higher rate of production and at a lower cost.

✦ ✦ ✦

LIME tubs should be cleaned frequently to avoid deficiency of binder in the coating and poor adherence and flaking. This was the advice of **D. E. Washburn**, chief chemist, American Lime & Stone division, Warner Co., Bellefonte, Pa. He announced that X-ray studies are at present being made in the hope that various physical phenomena in lime and lime products may be revealed.

✦ ✦ ✦

AMONG the Non-Ferrous papers presented, the one by **H. Blount,** Development Engineer, Western Electric Company, Baltimore, Maryland, and **J. E. Wiltrakis,** in charge of Engineering, Western Electric Company, Kearny, New Jersey, was outstanding.

✦ ✦ ✦

IN this paper, many facts relating to manufacturing methods and production of copper wire were frankly revealed and many new points of operating interest were presented for the first time.

✦ ✦ ✦

The Medal Award

THE association's annual medal for the most meritorious paper on wire manufacture or fabrication during the year was awarded **R. W. Sandelin,** metallurgist, Atlantic Steel Co., Atlanta, Ga. Honorable mention was awarded **H. Blount,** development engineer, Western Electric Co., Baltimore, and **J. E. Wiltrakis,** in charge of engineering and wire mill operation, Western Electric Co., Kearny, N. J.

WIRE QUALITY... PLANT PRODUCTION

Stepped Up WITH TECO Carbide DIES

You increase efficiency all down the line when wire drawing is entrusted to TECO Carbide Dies. TECO draws not only more wire tonnage per die, but finer *finished* wire! And that's only the start of the story! Add to your profits from stepped-up production the economy of TECO's dependable, long-life performance. You have fewer plant interruptions with TECO Carbide Dies, fewer wire rejects, less delay for die changing and refinishing. TECO is a hard, tough carbide composition, even and exceptionally slow to wear! It gives wire a high polish, smooth, uniform finish.

It will pay you to investigate the many money-saving, money *making* advantages of TECO Carbide Dies. A Tungsten Electric engineer will be glad to discuss with you your wire drawing problems and show you in your own plant how TECO Dies lower drawing costs and increase production. Why not consult us today?

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Never Say Die—always specify
TECO CARBIDE DIES
for smooth wire drawing--they last longer!

Tungsten Electric supplies carbide blanks, tools and bits. Wire and bar dies, tubing, extruding and sizing dies. Also, special tools, such as spot facers, reamers, broaches, form tools, etc.

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Branch Office: 2900 Euclid Ave., Cleveland, O.

Outstanding Personalities of the Wire Industry

Kenneth S. Wyatt, Cable Engr., Habirshaw Cable & Wire Division

ANNOUNCEMENT is made of the appointment of **Kenneth S. Wyatt**, cable engineer, to the staff of the Habirshaw Cable and Wire Division of the Phelps Dodge Copper Products Corporation of New York.

✦ ✦ ✦

MR. WYATT, widely known in engineering circles here and abroad for his many technical papers, several of which were awarded prizes by engineering societies, formerly was technical director of the Enfield Cable Works, Ltd., of London, England, and in recent years has been engaged in the development of the Hochstadter Compression Cable, having installed two systems for the Central Electricity Board of London, and others in Yorkshire and Hackney-Walthamstow, near London.

✦ ✦ ✦

PRIOR to his work in England, Mr. Wyatt was associated with the Detroit Edison Company for nearly ten years, developing improvements in high voltage cable insulation, both through research, particularly the development of analytical methods for detecting deterioration and evaluating cable quality, and also through extensive committee work in the American Institute of Electrical Engineers, and in the Association of Edison Illuminating Companies.

✦ ✦ ✦

FOR a number of years before going to England, Mr. Wyatt served as a member of the Research Committee, and the Edison Gold Medal Committee of the American Institute of Electrical Engineers, the High Tension Cable Committee of the Association of Edison Illuminating Companies, and Chairman of its sub-committee on Cable Research.

✦ ✦ ✦

IN 1934 Mr. Wyatt received the A.I.E.E. National Prize for the best Initial Paper (jointly with E. W. Spring and C. M. Fellows) and in 1939 he was awarded the A.I.E.E. National Prize for the Best Paper on Theory and Research (jointly with D. L. Smart and I. M. Reynar), entitled "Mechanical Uniformity of Paper Insulated Cables," given before the Winter Convention in New York, January, 1938.

✦ ✦ ✦

MR. WYATT is a native of London, and was educated in Canada and at Harvard University. He is a member of the American Institute of Electrical Engineers, the American Chemical Society and several other technical associations and committees.

✦ ✦ ✦

Philip M. Patterson

ON September 2, Philip M. Patterson passed away at his home at West Roxbury, Massachusetts. His loss is felt not alone by the Torrington Manufacturing Company, for whom Mr. Patterson had been New England Representative, but by his associates and business acquaintances made throughout the territory during the period of his active and efficient service.

✦ ✦ ✦

KENNETH S. WYATT
Cable Engineer, Habirshaw Cable & Wire Division, Phelps Dodge Copper Products Corp.

Norton Company Announces Changes in Sales Department

NORTON Company of Worcester, Mass., announces several transfers in the Sales Department of the Abrasive Division. **C. Milton Ekberg** of the Sales Engineering Department, Worcester, has been appointed Field Engineer in the Chicago districts and **William A. Russell** has been appointed Field Engineer in the Pittsburgh territory.

✦ ✦ ✦

ALDEN P. JOHNSON, also a member of the Sales Engineering Department, has been transferred to South Bend, Indiana as a salesman assisting **J. B. Eckstedt. J. L. deVou**, who has been engaged in field engineering work in the Chicago and Cleveland districts, has been appointed a salesman with headquarters in Toledo, Ohio, assisting **R. H. Cannon**.

✦ ✦ ✦

Robert H. Perry, Sales Engineer, Ajax Electric Company, Inc.

ROBERT H. PERRY, formerly employed by the Brown Instrument Company, is now in the employ of the Ajax Electric Company, Inc., as Sales Engineer at Buffalo, New York.

✦ ✦ ✦

W. C. Weslow, Mgr., Mining Div., Carboloy Co., Inc.

THE appointment of **W. C. Weslow** as Manager of the Mining Division of Carboloy Co., Inc., has been announced by W. G. Robbins, Carboloy President.

✦ ✦ ✦

MR. WESLOW came to Carboloy Company in 1931 from the Ross Manufacturing Company in Cleveland. For the past nine years he has been Field and Development Engineer in connection with diamond impregnated tools. Announcement of his appointment as Manager of the Mining Division coincides with the release by Carboloy Company for commercial useage of its Sinta-set diamond impregnated core bits.

STATISTICS --- AUGUST, 1940

PRODUCTION FOR SALE OF IRON AND STEEL PRODUCTS

35-200-8-40.

AMERICAN IRON AND STEEL INSTITUTE
Capacity and Production for Sale of Iron and Steel Products

August - 1940
PERIOD

		Number of companies	Items	Annual Capacity Net tons	Production for Sale—Net Tons: Current Month: Total	Current Month: Per cent of capacity	Current Month: Shipments: Export	Current Month: Shipments: To members of the industry for conversion into further finished products	To Date (8 Months 1940): Total	To Date: Per Cent of capacity	To Date: Shipments: Export	To Date: Shipments: To members of the industry for conversion into further finished products
Steel Products	Ingots, blooms, billets, slabs, sheet bars, etc.	34	1	xxxxxxx	686,513	xxx	440,486	106,071	3,261,106	xxx	1,516,122	715,711
	Heavy structural shapes	8	2	5,205,300	330,781	75.0	80,321	xxxxxxx	1,771,155	51.0	229,892	xxxxxxx
	Steel piling	4	3	328,000	19,804	71.3	223	xxxxxxx	111,833	51.1	9,598	xxxxxxx
	Plates—Sheared and Universal	20	4	6,095,450	386,999	74.9	62,293	2,211	2,512,771	61.8	374,440	14,475
	Skelp	8	5	xxxxxxx	90,685	xxx	23,557	28,649	466,973	xxx	80,064	173,588
	Rails—Standard (over 60 lbs.)	4	6	3,647,600	115,985	37.5	60,731	xxxxxxx	1,140,741	46.9	143,626	xxxxxxx
	Light (60 lbs. and under)	6	7	306,800	13,285	51.1	5,258	xxxxxxx	73,635	36.0	23,384	xxxxxxx
	All other (Incl. girder, guard, etc.)	2	8	118,000	1,141	11.4	-	xxxxxxx	18,042	22.9	2,382	xxxxxxx
	Splice bar and tie plates	15	9	1,300,200	22,374	20.3	360	xxxxxxx	376,261	43.4	6,509	xxxxxxx
	Bars—Merchant	35	10	xxxxxxx	491,029	xxx	125,484	35,670	2,830,904	xxx	401,259	219,207
	Concrete reinforcing—New billet	15	11	xxxxxxx	127,632	xxx	20,894	xxxxxxx	810,918	xxx	188,580	xxxxxxx
	Rerolling	18	12	xxxxxxx	13,819	xxx	592	xxxxxxx	95,698	xxx	5,109	xxxxxxx
	Cold finished—Carbon	18	13	xxxxxxx	61,206	xxx	2,021	xxxxxxx	422,128	xxx	10,591	xxxxxxx
	Alloy—Hot rolled	15	14	xxxxxxx	103,447	xxx	14,900	7,196	596,358	xxx	48,704	41,213
	Cold finished	15	15	xxxxxxx	8,803	xxx	480	xxxxxxx	58,817	xxx	1,972	xxxxxxx
	Hoops and baling bands	5	16	xxxxxxx	9,403	xxx	859	xxxxxxx	69,458	xxx	6,567	xxxxxxx
	TOTAL BARS	54	17	12,372,465	815,339	77.8	165,230	42,866	4,884,281	59.2	662,782	260,420
	Tool steel bars (rolled and forged)	15	18	110,220	6,331	67.8	694	xxxxxxx	44,532	60.6	3,601	xxxxxxx
	Pipe and tube—B. W.	13	19	1,815,860	110,705	71.9	5,469	xxxxxxx	650,808	53.8	50,459	xxxxxxx
	L. W.	10	20	1,246,340	34,070	32.3	1,805	xxxxxxx	226,658	27.3	22,931	xxxxxxx
	Electric weld	5	21	735,520	31,211	50.1	5,199	xxxxxxx	186,079	37.9	20,005	xxxxxxx
	Seamless	15	22	3,159,840	138,280	51.6	12,238	xxxxxxx	1,141,001	54.2	113,960	xxxxxxx
	Conduit	6	23	151,145	7,470	58.3	322	xxxxxxx	45,530	45.2	1,367	xxxxxxx
	Mechanical Tubing	13	24	554,825	25,459	54.2	2,402	xxxxxxx	178,029	48.1	12,867	xxxxxxx
	Wire rods	19	25	xxxxxxx	137,056	xxx	60,424	17,965	741,211	xxx	226,294	116,203
	Wire—Drawn	37	26	2,255,210	140,010	73.3	18,480	888	911,935	60.6	113,101	7,076
	Nails and staples	19	27	1,091,690	55,113	59.6	4,470	xxxxxxx	396,055	54.4	44,663	xxxxxxx
	Barbed and twisted	16	28	438,270	15,359	41.4	4,371	xxxxxxx	136,726	46.8	30,948	xxxxxxx
	Woven wire fence	15	29	772,790	13,298	20.3	154	xxxxxxx	163,278	31.7	1,560	xxxxxxx
	Bale ties	11	30	119,050	9,298	92.2	-	xxxxxxx	48,513	61.1	144	xxxxxxx
	All other wire products	6	31	27,030	2,050	89.5	-	xxxxxxx	10,300	57.1	-	xxxxxxx
	Fence posts	13	32	147,485	4,153	33.2	202	xxxxxxx	37,049	37.7	692	xxxxxxx
	Black plate	12	33	653,295	24,813	44.8	3,449	293	243,332	55.9	33,431	55,963
	Tin plate—Hot rolled	9	34	1,201,960	31,809	31.2	3,548	xxxxxxx	328,360	41.0	70,929	xxxxxxx
	Cold reduced	10	35	2,930,860	211,721	85.3	16,955	xxxxxxx	1,579,724	80.8	263,990	xxxxxxx
	Sheets—Hot rolled	26	36	xxxxxxx	539,028	xxx	45,317	9,345	3,495,909	xxx	352,504	95,290
	Galvanized	16	37	xxxxxxx	131,925	xxx	12,834	xxxxxxx	884,648	xxx	111,514	xxxxxxx
	Cold rolled	18	38	xxxxxxx	201,597	xxx	4,204	xxxxxxx	1,441,492	xxx	56,518	xxxxxxx
	All other	15	39	xxxxxxx	52,251	xxx	2,249	xxxxxxx	373,000	xxx	16,835	xxxxxxx
	TOTAL SHEETS	27	40	13,255,610	924,801	82.3	64,604	9,345	6,195,049	70.1	537,371	95,290
	Strip—Hot rolled	24	41	3,525,110	136,899	45.8	7,618	25,842	911,813	38.8	55,641	107,580
	Cold rolled	35	42	1,313,360	72,336	65.0	1,870	xxxxxxx	462,497	52.8	11,789	xxxxxxx
	Wheels (car, rolled steel)	5	43	424,385	16,533	46.0	23	xxxxxxx	124,320	43.9	2,439	xxxxxxx
	Axles	5	44	472,280	8,492	21.2	58	xxxxxxx	55,824	17.7	1,777	xxxxxxx
	Track spikes	11	45	327,275	7,696	28.8	296	xxxxxxx	74,202	34.0	2,787	xxxxxxx
	All other	3	46	9,100	1,196	155.1	-	xxxxxxx	6,812	112.3	-	xxxxxxx
	TOTAL STEEL PRODUCTS	134	47	xxxxxxx	4,649,065	xxx	1,053,110	234,130	29,516,435	xxx	4,671,545	1,546,306
	Estimated total steel finishing capacity based on a yield from ingots of 68.9 %	-	48	53,946,300	xxxxxxx	96.6	xxxxx	xxxxxxx	xxxxxxx	77.8	xxxxxxx	xxxxxxx
	Pig iron, ferro manganese and spiegel	26	49	xxxxxxx	536,667	xxx	100,681	119,948	3,590,343	xxx	369,783	949,272
	Ingot moulds	4	50	xxxxxxx	52,003	xxx	477	xxxxxxx	288,467	xxx	2,483	xxxxxxx
Iron Products	Bars	10	51	160,600	3,316	24.4	-	64	19,517	18.2	105	1,505
	Pipe and tubes	3	52	109,377	4,134	44.6	104	xxxxxxx	25,732	35.3	685	xxxxxxx
	All other	3	53	71,180	728	12.1	83	86	7,989	16.8	1,560	2,103
	TOTAL IRON PRODUCTS (ITEMS 51 to 53)	12	54	276,247	8,178	34.9	187	150	53,238	28.9	2,350	3,608

Total number of companies included- 153

Total steel products produced for sale, less shipments to members of the industry for conversion into further finished products: Current month 4,414,935 *N.T.;* 96.6 *% of Finishing Capacity.*
To date 27,970,129 *N.T.;* 77.8 *% of Finishing Capacity.*
The above tonnages represent 68.9 *% of the ingots produced by companies whose products are included above.*

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For detailed information address

RICHARD E. BROWN, Secretary

THE WIRE ASSOCIATION

300 Main Street, Stamford, Conn.

Exports and Imports of Wire

Exports of Iron and Steel Wire Products in Aug. 1940 and Aug. 1939
(In gross tons)

	AUG. 1940	JULY 1940	AUG. 1939
Wire rods	42,145	21,162	1,477
Strip steel	23,376	17,992	9,878
Plain, black or galvanized iron or steel wire	13,694	13,457	4,456
Barbed wire and woven wire fencing	6,388	3,859	3,651
Woven wire screen cloth	278	227	101
Wire rope	1,331	1,012	171
Insulated iron or steel wire and cable—see analysis below			
Other wire and manufactures	785	1,486	578
Wire nails	4,457	5,524	1,726
Tacks	70	112	32
Other nails, including staples	444	687	431
Bolts, machine screws, nuts, rivets and washers	5,033	2,192	570
Total, these 11 classifications	98,001	70,075	23,071

Imports of Iron and Steel Wire Into the United States
(In gross tons)

Concrete reinforcement bars	.....	.....	330
Hollow bar and drill steel	10	27	129
Wire rods	5	18	775
Barbed wire	.....	42	1,621
Round iron and steel wire	43	20	209
Telephone and telegraph wire	.....	.....	5
Flat wire and strip steel	396	256	309
Wire rope and strand	19	41	113
Other wire	.....	.....	103
Hoops and bands	.....	.....	2,010
Nails, tacks and staples	2	1	614
Bolts, nuts and rivets	1	3	13
Total, these 12 classifications	476	408	6,231

Export of Insulated Wire and Cable, August 1940

	Foreign		To U. S. Possessions	
	Pounds	Dollars	Pounds	Dollars
Rubber covered wire	1,085,985	$ 289,430	202,645	$ 39,493
Weatherproof wire	127,692	22,576	53,386	9,843
Other insulated copper wire	3,050,494	780,092	281,745	51,673
Nickel-chrome electric resistance wire	28,364	38,293	59	65
Total, these 4 classifications	4,292,535	$1,130,391	537,835	$101,074

Iron and Steel Exports at New High in August; Import Trade Registers Further Decline

EXPORTS of iron and steel products (scrap excepted) from the United States set a new high when, in August, the trade totaled 1,046,084 gross tons, valued at $53,870,693. July exports had amounted to 707,809 gross tons valued at $39,511,996 while those of August, 1939 were only 185,182 gross tons valued at $13,282,599.

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OVER the first eight months of 1940, exports of iron and steel totaled 4,524,507 tons valued at $291,352,901—more than three and one-half times as much in quantity and nearly three times as great in value as had been shipped to these same markets in the comparable period of 1939 — 1,272,055 tons valued at $95,678,644.

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Import Trade Lower

IMPORTS of iron and steel products (scrap excepted) registered another sharp decline in August when trade totaled only 2,089 gross tons of these materials valued at $516,187. July receipts had totaled 3,390 gross tons valued at $351,826 while in August, 1939 the trade in these goods had amounted to 24,569 gross tons valued at $1,354,288.

✦ ✦ ✦

OVER the first eight months of 1940 imports of iron and steel totaled only 44,267 gross tons valued at $5,367,590—21 percent by quantity and 42 percent by value of the 214,306-ton, $12,665,984 trade of the comparable period of 1939.

Scrap Exports in Slight Gain

EXPORTS of scrap — 355,991 tons—were slightly higher in August than in July when the trade had amounted to 327,129 gross tons valued at $5,459,356. Eight months cumulative scrap exports show the 1940 trade to be well under the levels set in 1939—exports having amounted to 2,430,914 gross tons against the 1940 figure for the same period of 2,164,225 tons.

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THE August 1940 trade of 355,991 tons included 346,087 tons of iron and steel scrap, 396 tons of tin plate circles, 220 tons of waste-waste tin plates, and 9,288 tons of terne plate scrap. Leading purchaser of iron and steel scrap was Japan with takings amounting to 137,429 tons. Great Britain ranked second with a trade of 136,604 tons, to be followed by Canada taking 55,111 tons.

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United Kingdom Chief Market

CONTINUED large purchases of ingots, blooms, etc., again made the United Kingdom the month's leading export market with a total of 653,866 tons of iron and steel, which included 287,318 tons of non-alloy ingots, 119,139 tons of pig iron and 41,602 tons of non-alloy plates. Non-alloy ingots, blooms, etc., 27,473 tons; non-alloy plates, 12,451 tons; and plain structural shapes, 9,768 tons were among the more important items of Canada's 108,017 ton trade. Japan with a total of 66,829 tons ranked third, followed by Argentina, 37,156 tons; Union of South Africa, 22,859 tons; Brazil, 14,443 tons; and the Philippine Islands, 13,175 tons.

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Continued Decline in Imports

PIG iron was the chief commodity imported in August in point of tonnage received — the 882-tons total including 662 tons from British India and 220 tons from Canada with receipts of flat wire and steel strip—396 tons—all coming from Sweden relegated to second place. Receipts of ferromanganese — 267 tons — are all accredited to Norway and was an-

(*Please turn to Page 686*)

Something you ought to know

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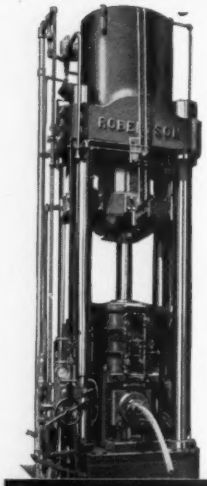

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Exports and Imports of Wire

(*Continued from Page 685*)

other outstanding commodity imported during the month.

✦ ✦ ✦

Scrap Receipts Down

RECEIPTS of scrap iron and steel in August amounted to 16 tons valued at $148—this total comparing with 152 tons valued at $2,286 imported in July. Scrap imports in the January-August period amounted to 1,428 tons valued at $39,780 against a trade of 21,967 tons, valued at $221,727 in the comparable 1939 period.

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Miscellaneous Items in July Import Trade

IRON ORE: 193,854 tons (249,397 tons in July) coming principally from Chile, 154,400 tons; Canada, 21,604 tons, Brazil, 11,500 tons and Cuba, 5,800 tons.

✦ ✦ ✦

Wood Screws

EXPORTS of iron and steel wood screws during August, 1940 totaled 118,847 gross valued at $18,859. Of this total The Philippine Islands took 62,235 gross valued at $9,617; Cuba, 22,564 gross valued at $2,659; Colombia, 7,737 gross valued at $1,626; Union of South Africa, 6,056 gross valued at $829; British India, 3,350 gross valued at $430; Canada, 3,191 gross valued at $586; Venezuela, 2,551 gross valued at $656; Republic of Panama, 2,066 gross valued at $457; Ecuador, 1,813 gross valued at $263; Nicaragua, 1,336 gross valued at $255; Mexico, 1,247 gross valued at $220; Netherlands West Indies, 800 gross valued at $128; Bolivia, 725 gross valued at $112; and Costa Rica 480 gross valued at $81.

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EXPORTS of brass wood screws during the same period totaled 16,804 gross valued at $7,259. Of this total the Philippine Islands took 8,780 gross valued at $3,915; Cuba, 2,395 gross valued at $602; Panama Canal Zone, 1,760 gross valued at $905; Netherlands Indies, 750 gross valued at $290; Costa Rica, 597 gross valued at $372; Canada, 512 gross valued at $175; Uruguay, 433 gross valued at $236; New Zealand, 415 gross valued at

$190; Argentina, 400 gross valued at $130; Mexico, 251 gross valued at $192; and Colombia, 167 gross valued at $74.

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IMPORTS of wood screws during the same period were none.

✦ ✦ ✦

Swedish Output Declines

LONG dependent for its prosperity on export markets for its high-quality output the Swedish steel industry has been seriously and adversely affected by the blockades imposed by the warring powers. Although statistics are not available it is reported that production has declined steadily since February. Originally the local arms industry took up much of the slack, but of late demand from that source has declined and sales of commercial iron—to the production of which the industry turned when denied access to export markets—have also been contracting. Sales will be made to such nearby markets as Finland, Denmark and Norway and it is reported that Soviet Russia is negotiating for long-term deliveries of steel, but at the moment the outlook is for a continued decline in both backlog and operations.

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New Bolt Company Formed in South Africa

WITH its plant located (and nearing completion) in Industria, a suburb of Johannesburg, the Black Bolt and Engineering Company plans to commence production of nuts, bolts, rivets and small forgings during June, 1940.

✦ ✦ ✦

Gauge Measures Steel Strips

AN electric-eye gauge that controls the width of strips of sheet steel while they are being rolled has been developed in the laboratories of the General Electric Company. It monitors both edges of the moving strip simultaneously for width, regardless of sidewise motion, making possible the immediate adjustment of the machine to bring the strips to standard dimensions. This eliminates possible rejection of material because it is undersize, and makes trimming unnecessary.

that Makes Production Sing!

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Bright-Tinned
Coppered
Annealed
Galvanized

A Review of Recent Wire Patents

No. 2,213,344, WIRE-DRAWING MACHINE, patented September 3, 1940 by Charles D. Johnson, Worcester, Mass., assignor to Johnson Steel & Wire Company, Inc., Worcester, Mass., a corporation of Massachusetts.

Water for cooling the wire-drawing block is sprayed against the interior walls of the block and provision is had for draining the water from the block.

✦ ✦ ✦

No. 2,213,630, SOCKETED CAP SCREW AND METHOD OF PRODUCING SAME, patented September 3, 1940 by Harald F. Gade, Philadelphia, Pa., assignor to Standard Pressed Steel Co., Jenkintown, Pa., a corporation of Pennsylvania.

The method consists in separately forming the working and operating portions of the screw each of metal having a composition consistent with the function of the portion in the screw, the working portion including the shank of the screw and the adjoining transverse portion of the head and the operating portion embracing the socketed portion of the head, and uniting the portions by welding restricted to a narrow peripheral band adjoining the outer surface of the head.

✦ ✦ ✦

No. 2,214,025, WIRE FORMING APPARATUS, patented September 10, 1940 by Homer W. Larson, Downers Grove, Ill., assignor to Western Electric Company, Incorporated, New York, N. Y., a corporation of New York.

Complete Descriptions and Drawings of Patents May Be Had for 25 cents. Address, Wire & Wire Products, 300 Main St., Stamford, Conn.

Wire is wound upon a mandrel, which is keyed within the tubular portion of a sliding and rotating shaft, and when the wire is wound, endwise movement of the shaft will strip the formed wire from the mandrel.

✦ ✦ ✦

No. 2,214,058, THREAD CUTTING MEANS, patented September 10, 1940 by Louis G. Larsen, Jersey City, N. J., assignor of one-half to Herman Neuwirth and one-half to Benjamin E. Winston, both of Brooklyn, N. Y.

The work, in its rotation, rotates the thread cutters and causes it to bring successive cutting teeth into cutting engagement with the work.

✦ ✦ ✦

No. 2,214,135, SPRING STRUCTURE FOR USE IN BED MATTRESSES, PILLOWS, AND CUSHIONS, patented September 10, 1940 by Harold Hickman, Dallas, Texas, assignor to Leggett and Platt Spring Bed and Manufacturing Company, Carthage, Mo.

In this spring structure the springs, which are of gradually decreasing convolutions, are so disposed that the outer edges of all of the convolutions be in about the same vertical plane on each side of the spring. Connecting ties of spring wire connect the outer convolutions and the next adjacent convolutions of the first-mentioned springs.

✦ ✦ ✦

No. 2,214,709, PRESTRETCHING OF WIRE ROPES AND THE LIKE, patented September 10, 1940 by Leonard C. Peskin, Worcester, Mass., assignor to The American Steel and Wire Company of New Jersey, a corporation of New Jersey.

An apparatus is provided which comprises spaced coiling and uncoiling devices to provide a span of the wire rope, with the rope under tension, and devices for vibrating the rope.

✦ ✦ ✦

No. 2,214,739, WIRE FABRIC, patented September 17, 1940 by Raymond J. Guba, Philadelphia, Pa., assignor to Audubon Wire Cloth Corporation, Philadelphia, Pa., a corporation of New Jersey.

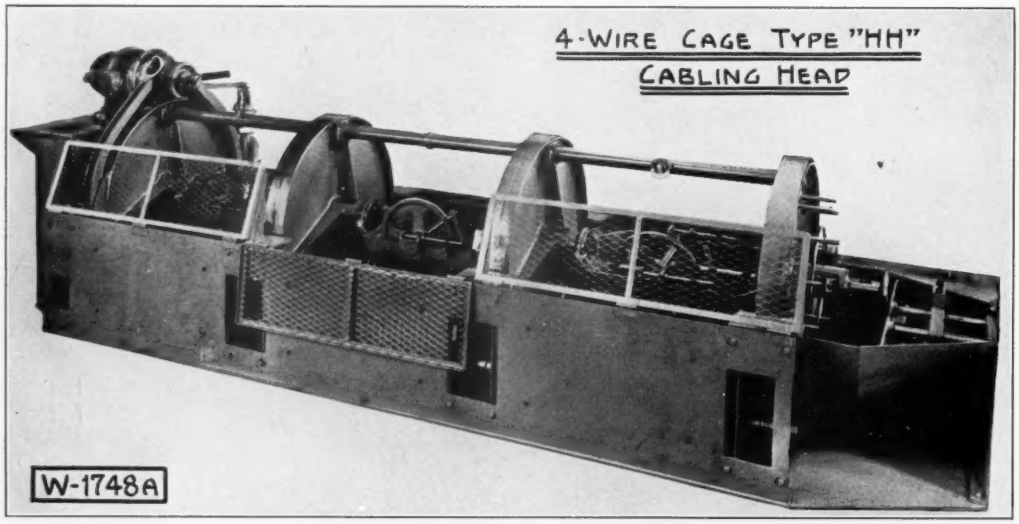
Helically coiled wires make up the fabric to provide belts with short, helically coiled wires interlocked at each side edge of the belt to form reinforcing selvages.

THE WATSON MACHINE COMPANY

ESTABLISHED 1845

PATERSON, NEW JERSEY, U. S. A.

HIGHEST MACHINE SPEEDS



16", 24", 30" & 40" SPOOL SIZES

No. 2,215,092, PREVENTING CORROSION OF FERROUS METALS, patented September 17, 1940 by Herman A. Beekhuis, Jr., Petersburg, Va., and William De Forest Macomber, Clay, N. Y., assignors, by mesne assignments, to The Solvay Process Company, New York, N. Y., a corporation of New York.

A solution of ammonium nitrate, containing free ammonia, is employed, and the process comprises dissolving in the solution a compound containing divalent sulfur linked to carbon in amount sufficient to materially decrease the rate of corrosion of a ferrous metal by the solution, and contacting the solution with the ferrous metal.

✦ ✦ ✦

No. 2,215,235, WIRE DRAWING APPARATUS, patented September 17, 1940 by Earl D. Tubbs, New York, N. Y., assignor to Igoe Brothers, Inc., Newark, N. J.

This assembly includes a primary drum and a wire coiling drum, segmental slip shoes placed about the primary drum, means upon the drum for retaining the shoes thereon, and a removable segmental lock member forming part of the retaining means, the removal of the segmental lock member permitting the release of the shoes.

✦ ✦ ✦

No. 2,215,278, TIN COATING PROCESS, patented September 17, 1940 by Carl E. Swartz, Cleveland Heights, and Donald L. V. Schwartz, Cleveland, Ohio, assignors to The Cleveland Graphite Bronze Company, Cleveland, Ohio, a corporation of Ohio.

In order to coat iron with tin, these inventors heat the iron to or above the gamma iron formation critical temperature and in an atmosphere sufficient to de-oxidize and decarburize the surface thereof, and then while the metal is at or above the temperature applying a coating of molten tin to the surface.

✦ ✦ ✦

No. 2,215,477, METHOD OF MANUFACTURING WIRE, patented September 24, 1940 by Marvin Pipkin, Cleveland Heights, Ohio, assignor to General Electric Company, a corporation of New York.

This method has to do with manufacture of wire of a relatively brittle metal (aluminum) for photo flash light lamps. In drawing, the metal is imbedded in a jacket of ductile metal (such as copper).

✦ ✦ ✦

No. 2,215,734, AUSTENITIC STEEL, patented September 24, 1940 by Oscar E. Harder, Columbus, Ohio, assignor to Inland Steel Company, Indiana Harbor, Ind., a corporation of Delaware.

A steel is provided containing carbon from effective amounts to 1.7 per cent and lead from .03 to 1 per cent with at least a portion of the lead being substantially uniformly dispersed, said steel having a substantially austenitic structure being characterized by improved machinability in comparison with the same steel having less than .03 per cent lead.

✦ ✦ ✦

No. 2,215,996, METHOD OF ELECTRICALLY INSULATING A CONDUCTOR, patented September 24, 1940 by Kenneth H. Benton, Pittsfield, Mass., assignor to General Electric Company, a corporation of New York.

The covering comprises a polyvinylal resin produced by condensing formaldehyde with a product of hydrolysis of polyvinyl ester and characterized by normally converting to the infusible insoluble state under extrusion time and temperature conditions, and the method consisting in heating the bare wire within the temperature range of 185° to 250° C. thereby to improve the adhesion to the wire of a subsequently applied coating of the resin and to improve the flexibility of the resin film on the finished insulated wire, extruding upon the thus heated wire a continuous, uniform covering of the polyvinylal resin having incorporated therein a relatively small proportion of an amine, said amine suppressing the conversion of the said resin to the insoluble infusible state during extrusion, and heating the thus modified resin during extrusion at approximately the same temperature to which the wire is heated.

✦ ✦ ✦

No. 2,216,010, HIGH TENSION ELECTRIC CABLE, patented September 24, 1940 by Henry M. Hobart, Niskayuna, N. Y., assignor to General Electric Company, a corporation of New York.

Highly porous insulating material supports the wire conductor and insulating gas, under high pressure is employed to fill these pores.

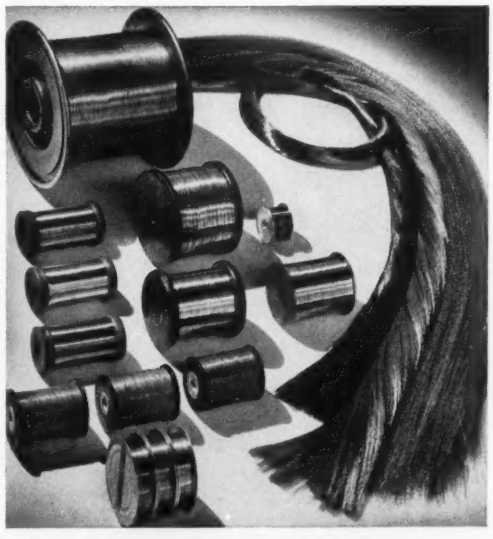
✦ ✦ ✦

No. 2,216,049, NAIL MACHINE AND NAIL MANUFACTURING, patented September 24, 1940 by Joseph A. Rice, Belle Vernon, Pa., assignor to The American Steel and Wire Company of New Jersey, a corporation of New Jersey.

More specifically, the invention relates to a double-headed nail making machine, particularly the hammer assembly.

IF YOUR WIRE'S SPECIAL . . .

A special shape, size or special alloy, you'll find it pays to consult Callite. Callite is equipped and geared to meet any wire requirement. Should yours be too specialized even for Callite's unusually wide range of standard wires, Callite can create a wire in its development laboratory exactly to specification quickly and economically. If need be, Callite metallurgists will gladly help in determining your wire specifications.



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listing Callite wires—stainless steel, steel brass, monel, aluminum, silver, commercial bronze, phosphor bronze, brush, Fourdrinier, and standard alloy wires down to .001", in a variety of shapes. Consult Callite on your special requirements.

CALLITE WIRES

CALLITE-TUNGSTEN CORPORATION

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WIRE FOR EVERY NEED — CALLITE TUNGSTEN — CT

American Steel & Wire Rehabilitates Worcester Plant

THE largest rehabilitation and improvement program ever undertaken by the American Steel & Wire Co., subsidiary of U. S. Steel Corp., in Worcester, the cradle of the American wire industry, was anonunced by **Carl I. Collins,** Worcester district manager for the company.

THE program includes four additions to the company's present South Works and complete rearrangement and improvements which will result in one of the most efficient wire mills in the United States.

✦ ✦ ✦

THE work will start immediately and plans call for completion within twenty months. The largest of the new buildings will house the manufacture of round and shaped wire and strip and is to be constructed South of the present South Works on a plot of land between Millbury Street and the New York, New Haven & Hartford R.R. tracks. This building will be 1,035 feet, or approximately 1/5 of a mile long and 500 feet wide. This will permit the manufacture of all the company's steel products now produced in Worcester under one roof. Connected with this mill will be a new two-story office building and physical laboratory, occupying approximately 17,000 square feet of floor space. The offices will include those of the mill superintendent and his staff.

✦ ✦ ✦

THE present Spring Mill at South Works will be rearranged and the rail bond and flat coiled spring operations will be consolidated in a new two-story building, 186'x120'. This building will be North of the present Cable Works and East of the present Spring Mill.

✦ ✦ ✦

THE company's copper facilities at Worcester also will be rearranged and consolidated in two new buildings, one of two stories—440'x60'—which will include the copper stranding operations and warehouse, and the other, one story — 400'x80'—which will include copper drawing, cleaning, annealing, cold rolling and tinning operations. These two buildings will be adjacent to each other and at the Southeast corner of the present Cable Works.

✦ ✦ ✦

WHEN the new mill is completed the present North Works and Central Works will be abandoned and the present wire drawing building at South Works will be demolished.

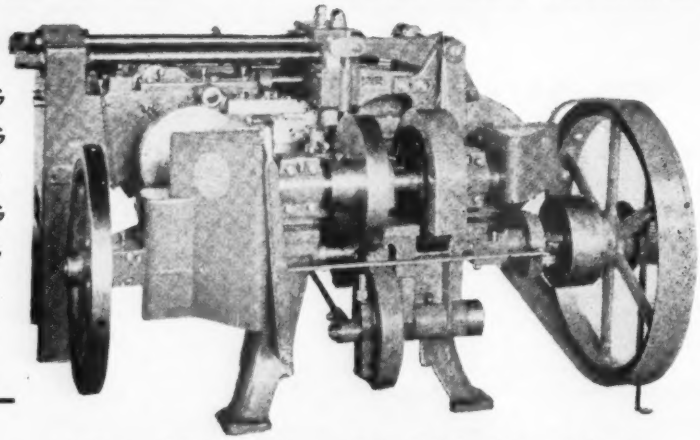
✦ ✦ ✦

"THE capacity of the company's Worcester operations will not be increased by the new program," Mr. Collins said. "The purpose of the project is to provide modern, centralized facilities capable of meeting the needs of New England for the company's various products."

NILSON

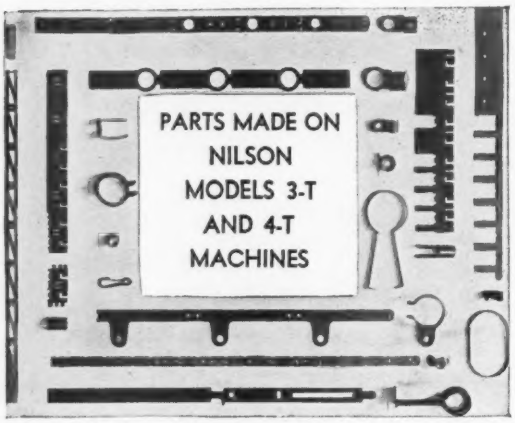
AUTOMATIC PRESS AND FOUR SLIDE MACHINE

FOR SWAGING STAMPING PIERCING BLANKING FORMING OF COILED METAL



A General Purpose, Heavy Duty Fabricating and Metal Forming Machine.

WE Build machines for forming Paper Clips, Buckles, Gate Hooks, Coat and Hat Hooks, Ceiling Hooks, Wire Ears, Cable Rings, Screw Eyes, Sash Chains, Automobile Side Chains, Flat Open Link Chains, Staples, Cotter Pins, Hose Clamps, Etc. and Wire Straighteners, Wire Reels, Frame Bending Machines and Special Presses.



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For Complete Details Address —

THE A. H. NILSON MACHINE CO.

BRIDGEPORT, CONN., U. S. A.

Screw Thread Standards For Federal Services

THE standards established by the former National Screw Thread Commission have been reissued with minor corrections and editorial changes by the National Bureau of Standards at the request of the Interdepartmental Screw Thread Committee. The document, Screw Thread Standards for Federal Services, Handbook H25 of the National Bureau of Standards, has been approved by the Interdepartmental Screw Thread Committee for use in the War, Navy and Commerce Departments. It presents dimensional information upon which specifications may be based for threaded products for Government requirements. The standards are intended to conform to generally accepted commercial practice, although certain special requirements of the Government necessitate the inclusion of some standards not ordinarily applicable outside the Government service, the National Bureau of Standards announces.

✦ ✦ ✦

THE Interdepartmental Screw Thread Committee which was established by the Departments of War, Navy and Commerce to promote uniformity in screw-thread standards in those Departments, is charged with responsibility for developing standards for screw threads; standardization of gages, dies, and taps; and standardization of dimensions of nuts, bolt heads, wrenches, and other items used for interchangeable threaded parts.

✦ ✦ ✦

WHEN the Committee was organized in 1939, the American Standards Association was invited by the Government to appoint liason representatives and named the following members of ASA committees concerned with screw thread problems:

Earle Buckingham, secretary of ASA Committee B1 on Screw Threads

J. H. Edmonds, member of ASA Committee B18 on Rivet Proportions

R. E. Flanders,[1] chairman of ASA Committee B1 on Screw Threads

A. M. Houser, member of ASA Committee B2 on Pipe Threads

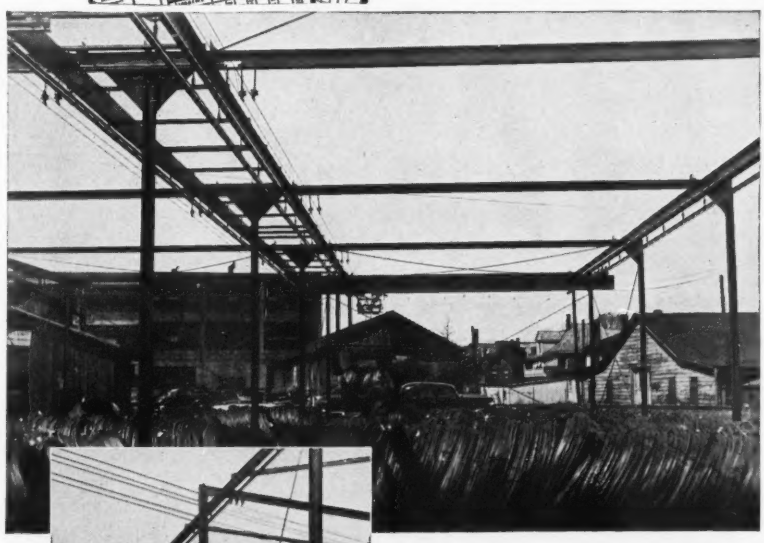
✦ ✦ ✦

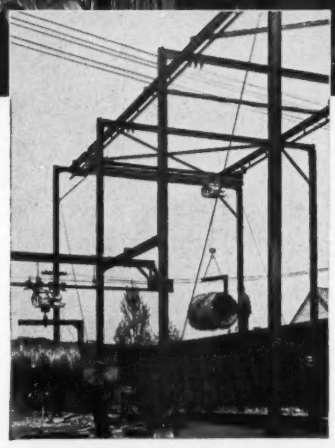
COPIES of National Bureau of Standards Handbook H25 can be purchased for 20 cents each from the Superintendent of Documents, Government Printing Office, Washington, D. C.

New Nail Catalog By J & L

JONES & Laughlin Steel Corporation, Pittsburgh, has released for distribution this week a new catalog, "J & L Nails and Wire Products—N-6." This catalog gives detailed information on the various types of nails, wire, fence, staples, and barbed wire manufactured by the corporation, showing sizes, finishes, and prices of the various products.

"Saves 32c per ton!" in handling cost - - -





Unloading and storing coiled rod from box cars formerly cost 40c per ton and required 5500 sq. ft. of warehouse space.

Now, raw coils are unloaded from gondolas, stored outside and handled through pickling to punches and cold-headers at 8c per ton.

A Clear Saving of 32c per Ton Made Possible by Overhead Handling

Innovations, such as a turntable for transferring coils between hoists, develop in conference with American MonoRail engineers.

AMERICAN MONORAIL CO.

13117 ATHENS AVE., CLEVELAND, OHIO

Scientific Price Management

FOR those who have pricing decisions to make—Executives, Sales Managers, retail store buyers and merchandise managers, production managers, auditors and trade association officials—the new handbook, SCIENTIFIC PRICE MANAGEMENT I, by Allen W. Rucker, recently published by the Eddy - Rucker - Nickels Company, Cambridge, Mass., is wholly unique.

MOST books dealing with prices and pricing run to theory; SCIENTIFIC PRICE MANAGEMENT I is a welcome contrast with its direct, realistic approach to everyday price problems. No less than fifteen different types of such problems, taken from actual case studies by the author's firm of management counsel, give the user of this manual virtually a complete guide to pricing problems. The case studies range from simple price-cuts to problems involving advertising allowances, freight allowances and sales bonuses; in addition, problems embracing added production required of factory employees to justify step-up differential piece-rates, added retail store sales needed to warrant promotion of lower-priced lines and increased volume necessary to justify "deals" and merchandise premiums.

✦ ✦ ✦

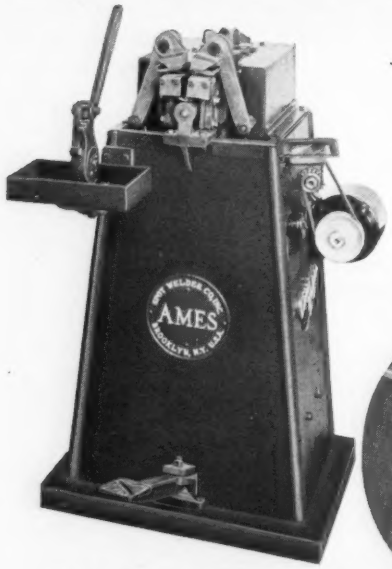
AS the author points out, few know how to compute the added volume needed to compensate for price discounts or added direct costs. The volume requirements vary both with (a) the percent of price-discount or cost increase and (b) with the original gross margin of profit. Mr. Rucker developed a decade ago the price-volume compensation formulae for computing such volume increases; now in SCIENTIFIC PRICE MANAGEMENT I he performs a notable service in providing the means to determine volume increases under every possible condition without any computation whatever.

✦ ✦ ✦

THAT is accomplished by six remarkable Calculator Charts, size 9x12", printed in two colors on index bristol board and incorporated in the manual. To find, for instance, the added volume necessary to justify a price discount of 25c per pair by a shoe manufacturer, one simply consults a Calculator Chart and reads off the answer (without computation) according to his individual margin percentage and percentage price-discount. To find, for example, the added volume needed to offset a 5% advertising allowance or a "deal" with one case free with six, or to offset increased social security taxes or sales bonuses, one simply looks up the answer on a Calculator Chart.

✦ ✦ ✦

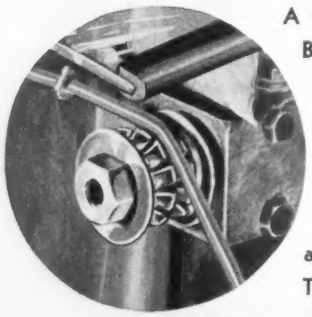
SCIENTIFIC PRICE MANAGEMENT I is not so much a book as it is a working manual for executives and one sure to be used constantly. It is recommended for every executive who must make decisions relative to prices or costs.



AMES BUTT WELDER

IB

INTRODUCING
TO THE
WIRE TRADE



BURR REMOVER
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A Combination Butt Welder Cutter and Burr Remover with new and distinct Time Saving Features.

Perfecting the art of removing the burrs from welded wire rods with new burr removing device. Cutters, that furnish clean cut rivet ends for stronger welds, all conveniently located and heat control on top of welder.

A sturdy, well built, and compact machine for Wire Mills where speed, control, and ease of operation is essential.

Carefully engineered and performance proven. Protected by American & Canadian Patents.

IGOE BROTHERS, INC.

AVE. A. & POINIER STREET NEWARK, N. J.

Bound in hard covers with plastic binding, with six cellophane-surfaced two-color Calculator Charts, and with a complete but brief explanatory text, this Manual supplies an executive tool which has long been needed. Available from the publishers, The Eddy-Rucker-Nickels Company, Harvard Square, Cambridge, Mass. ($5.00 the copy).

✦ ✦ ✦

British Production Up

ALTHOUGH just how badly the loss of Continental sources of iron ore may have affected the British steel industry is not known, it is reported that shipments from Spain and certain Mediterranean areas continue and these, together with the nearly fifty per cent increase (over the peace-time peak) in home production have made it possible for plants, not having reserves on hand, to cover their current requirements. Some idea of the importance attached to the domestic production of iron ore may be had from the recent order of the Ministry of Labour reserving all screeners and laborers in the iron industry over thirty years of age for their occupations and prohibiting them from serving in the armed forces.

For Information
Regarding
The Wire Association
Address
Richard E. Brown, Secretary
300 Main Street, Stamford, Conn.

✦ ✦ ✦

Chip Breaker Grinder Bulletin Issued by Carboloy

CARBOLOY Co., Inc., Detroit, Michigan, has released technical bulletin #GT-121 covering its new Chip-breaker grinder for use with cemented carbide tools designed for machining of steel. Complete operating instructions are given including types of wheels to be used, coolants, methods of exactly duplicating desired chip-breaker shape and size desired, etc.

Washer Firm Publishes New Stock List

THE Wrought Washer Mfg. Co. of Milwaukee, Wis., world's largest producer of washers, expansion plugs, stampings, tools and dies, serving the wire fabricating industry, has announced the publication of a new stock list —No. 55-D — available to wire product manufacturers upon request.

✦ ✦ ✦

THIS new publication lists thousands of washer specifications in various materials, including steel, brass, copper, aluminum, fibre, etc., carried in actual inventory available for immediate shipment. Those sizes permanently maintained in stock are so designated, thus enabling manufacturers to select for standard production as well as new assemblies the particular sizes on which they can always secure prompt delivery.

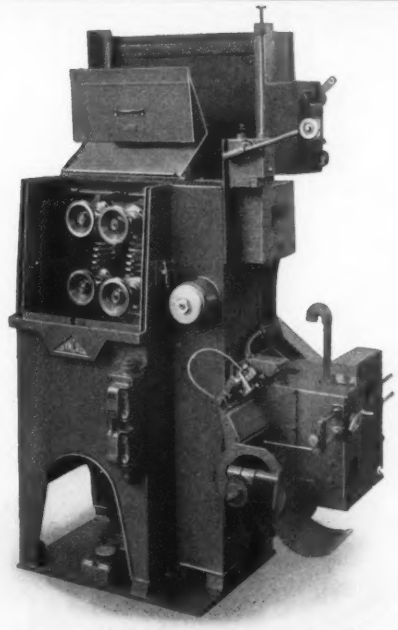
Syncro type AA Machine improved for greater efficiency

The Syncro type AA fine wire drawing machine has been redesigned and every detail has been properly proportioned to perform the work within its range with the highest efficiency.

The spooler will now take 10 to 15 lb. spools of #38 to#45 B & S gauge wire and the spooler construction is similar to that of the heavier Syncro type A and B machines.

If you are in the market for fine wire drawing equipment, the Syncro type AA machine is the answer to your problem.

Write for complete details and prices.



SYNCRO

SYNCRO • MACHINE • COMPANY

420 Lexington Ave., New York — McCormick Bldg., Chicago

Represented in Canada By—Canadian Elevator Equipment Co., Ltd., Toronto

Decarb Is A Bad Actor on Springs

IN its June bulletin, "Heat Treating Hints", The Lindberg Engineering Company, of Chicago, Illinois points out that decarb is a bad actor on springs. The bulletin states:

✦ ✦ ✦

PRODUCERS of quality springs are being pushed harder and harder by spring users to produce springs with ever increasing fatigue resistance. This is logical because in almost every industry speeds are being increased and this places a heavier burden on the springs. And because decarb has been found to be highly detrimental to the life of springs, much attention is being given to stock and heat treatment.

✦ ✦ ✦

WE have all had the experience of hardening a batch of springs and then had them fatigue due to a decarburized surface. Microscopic examination might show the decarb to be only a half thousandth or less, but nevertheless failure occurred, and the only traceable cause was decarburization. It was very naturally assumed that the decarb occurred in heat treatment. We recently had a case where we heat treated a batch of intricate springs in the Hydryzing Furnace and the customer found, when subjecting a few to his regular tests that some of them did not stand up at all. More were tested, and the same erratic results held. When checked under a microscope a definite zone of decarb was noted on the surface of most of the pieces, with some partial decarb here and there.

✦ ✦ ✦

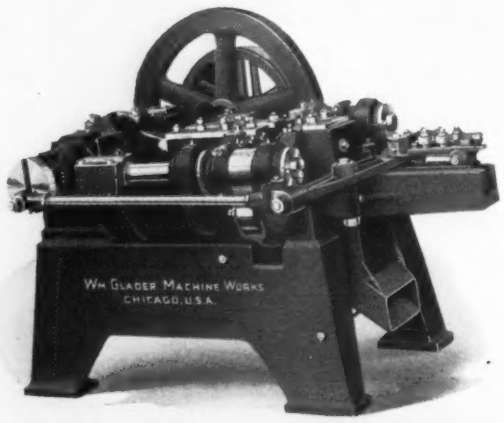
AT the same time several unheat treated samples were polished, etched and examined. These were found to be decarburized also. This loss of carbon had evidently occurred when the steel was being heated for rolling or being annealed, and there was very little that could be done about it after the springs had been made up.

IN these days the steel mills making spring stock exercise such very careful control over their product that mill decarb is very rare. However, when it does occur, mill decarb is a somewhat more serious matter when the springs are treated in a controlled atmosphere furnace which does not scale or change the surface in any way, than when they are treated in an open fire furnace which scales them. The reason is that if a slight decarb is present prior to treatment in the controlled atmosphere furnace, it will still be there when the springs come from the quench. If, however, the springs *scale* in heat treatment, there is a chance that most of the decarburized "bark" will be scaled off, although the gamble is a bad one.

✦ ✦ ✦

THE essentials then, in heat treating springs for high fatigue resistance are, first, spring stock with no decarburized surface; secondly, prevention of decarburization when the springs are hardened. The tilting hearth Hy-

HIGH SPEED WIRE NAIL MACHINE



WM. GLADER MACHINE WORKS

210 N. Racine Ave. Chicago, Illinois

Glader Machines on large head, single-blow roofing nails can be seen in operation at any of the independent wire mills in the United States.

The production figures on common nails shown below, are guaranteed.

SIZE MACH.	SIZE WIRE	MAX. LENGTH OF WIRE	NUMBER OF NAILS PER MIN.	CAP. IN POUNDS PER HR.
#00A	#16	1⅛"	700	37.2
#00	#14	1¼"	550	55
#0	#12	1¾"	450	89
#1	#10	2½"	400	192
#2	#8	3½"	325	310
#3	#4	5"	225	523
#4	#1	7"	190	622
#4s	5/16"	9"	175	1155
#5	⅜"	12"	160	2400

This high output and economical operation account for the GLADER machine being accepted as standard equipment in all recent installations.

dryzing Furnace enables springs and stampings to be hardened without decarburization, and at the same time they come from the quench tank bright, without a trace of scale. Thus, not only is good fatigue resistance assurred, but also cleaning operations such as sandblasting or tumbling after hardening are eliminated. A diagrammatic sketch of this furnace is shown in the sketch.

✦ ✦ ✦

THE Magnus Chemical Company, Inc., has just issued a new descriptive illustrated folder on its product, Magnus Cement Cleaner. ✦ ✦ ✦

MAGNUS Cement Cleaner is a concentrated powder from which a liquid floor cleaner is made by stirring into water. The greatest economy is obtained for the liquid cleaner made from the powder costs less than 3c per gallon. A gallon cleans 100 sq. ft.

✦ ✦ ✦

MAGNUS Cement Cleaner does more than remove crusts of oily dirt and grease. Consistent use of it WHITENS the cement, HARDENS and fills its surface, It quickly penetrates every crack and draws grease and oil to the surface, where they and the dirt can be easily flushed away with water. ✦ ✦ ✦

MAGNUS Cement Cleaner is safe to handle. It is non-inflammable, non-poisonous and contains no free alkali. The agreeable pine odor, which disappears in a short time, makes Magnus Cement Cleaner pleasant to work with. ✦ ✦ ✦

THE new folder completely describes the product and shows applications of it in industrial plants, airport hangars, garages and service stations.

✦ ✦ ✦

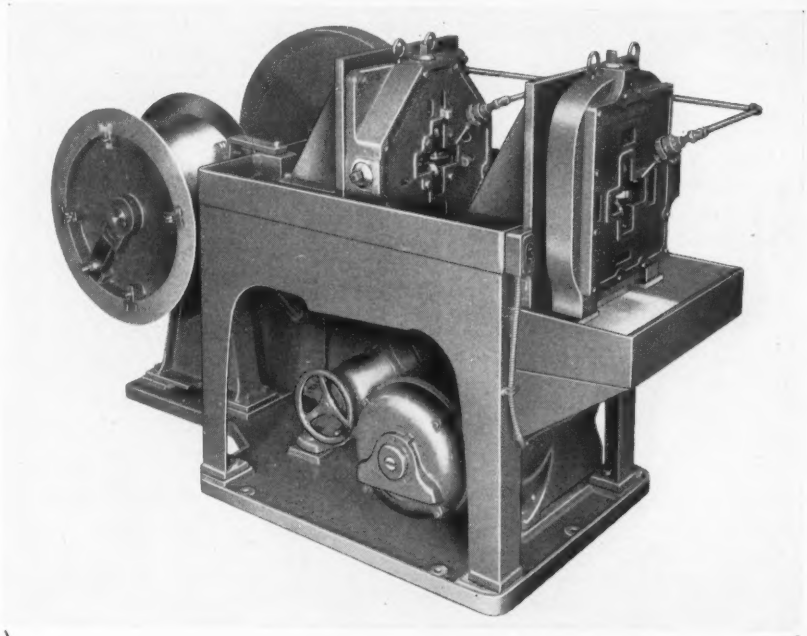
THOSE wishing a copy of the folder may obtain it by writing to the Magnus Chemical Company, Inc., Garwood, N. J.

✦ ✦ ✦

Foley Copper Products Company

THE Foley Copper Products Company of Dollar Bay, Michigan announce that after months of preparation their rod and wire mill will be ready for operation the first week in October. This is a noteworthy rehabilitation of an old plant and is considered not only an asset to the town of Dollar Bay but to the entire Copper Country as it is expected that people who have been out of production work for years will now be immediately re-employed. The President and Manager of the company is **John Foley.**

The Discussions at The Wire Association Meetings Will Be Published in Detail in the January, 1941 Issue of Wire and Wire Products.



RIGHT IN THE SPOTLIGHT AT CLEVELAND

STANDARD'S Tandem Mounted Turks Head operated at the Metals Show reducing .300" round to 3/16" square with sharp corners and to exacting tolerance — in one operation at 140 feet per minute!

Stands equipped with coolant circulating system are available for all sizes of Turks Heads.

Types range from variable speed drives to portable stands that are located in front of bull block.

Let us discuss possible applications of this machine to your work — address

IT'S STANDARD PRACTICE

STANDARD MACHINERY COMPANY

PROVIDENCE, RHODE ISLAND

Composition of Furnace Reducing Atmospheres

THE Committee on Industrial Gas Research of the **American Gas Association, Mr. F. J. Rutledge,** Chairman, has recently issued a new bulletin presenting results of several years of original research on the composition of furnace atmospheres resulting from partial combustion of gaseous fuels.

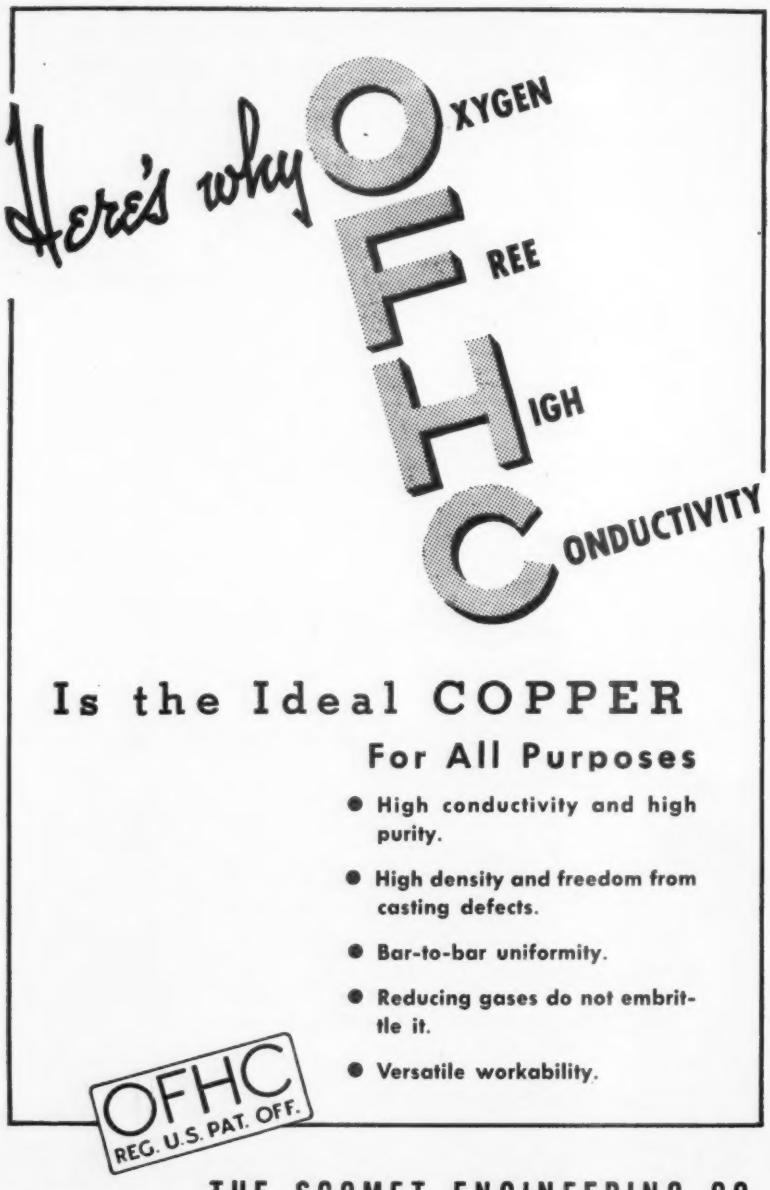
THIS bulletin comprises 94 printed pages and 37 graphs for presentation of data. In general, it presents practical means of obtaining furnace atmospheres of a predetermined composition, a guide to methods of interpreting test data obtained on gas-fired furnaces operating with a deficiency of combustion air, suggestions as to design of combustion chambers and burners in order to achieve a predetermined composition of flue gases, and new methods for determining heat content of flue gases containing unburned combustibles. A more detailed exposition of the nature and scope of data contained in this new research bulletin is briefly summarized below.

✦ ✦ ✦

IN an attempt to control the chemical effect of a furnace atmosphere on the material being heated, it is often endeavored to duplicate a procedure which has been successfully used previously for a similar heating process. One of the reasons why these attempts may result in failure to achieve the desired objective, lies in the fact that industrial furnaces generally are operated at a specified air-gas ratio without proper regard to composition of the fuel being burned at the time. The term "air-gas ratio" so commonly used in industrial combustion work really does not embody enough information, it also being necessary to relate it to the theoretical air-gas ratio for the gas used, or to know what percentage of the theoretical air requirements is being supplied at the time. Composition of gases, and consequently their theoretical air requirements, vary in different localities. In order to clarify this subject, helpful charts, showing how the theoretical air requirements of a gas vary as its heating value changes, are presented for both natural and coke oven gases.

✦ ✦ ✦

COMPLETE analyses of flue products resulting from combustion of a natural and two manufactured gases at any air supply between that theoretically required for complete combustion and the lowest supporting combustion are presented. These data show how the percentages of carbon dioxide and water vapor produced by combustion decrease, and the carbon monoxide and hydrogen contents of the flue gases increase, as air supplied for combustion is decreased. Charts, with special discussions, also show how the small but definite quantities of oxygen and hydrocarbons in the flue gases



vary with aeration, both maximum and minimum concentration points for each constituent being demonstrated.

✦ ✦ ✦

AN analysis of data disclosed that although combustion characteristics depend on the type of fuel gas, relative volumes of flue gas constituents formed are a function largely of the total amount of carbon and hydrogen, either free or combined, in the fuel gas and are little influenced by the molecular form in which the carbon and hydrogen are combined in the fuel. A chart is presented which shows the proportional division between carbon dioxide and carbon monoxide in the flue gases for various fuels when burned at various degrees of aeration. Similarly, percentages of total hydrogen in the fuel which appeared in the flue products as water and free hydrogen are illustrated. This chart, with sample calculations, provides a practical means of predicting the analysis of the flue gas which will result when a mixed gas or gas of unusual composition is burned with different amounts of air.

✦ ✦ ✦

FOR many engineering calculations it is necessary to know total volumes of flue gases formed at each air-gas ratio, rather than the relative quantities such as are obtained with an Orsat apparatus. Charts showing total volumes, as well as volumes of CO_2, CO, H_2, and H_2O formed by combustion of one cubic foot of natural or manufactured gas with different air supplies, are presented. Problems involving size of furnace flueways and stack, size of checkerwork in regenerative furnaces, size of recuperators, amount of heat lost through stack, size of waste heat boilers, amount of cooling necessary to remove water vapor from flue gases in treated atmospheres, and amount of chemical absorption required to remove CO_2 or other constituents in treated atmospheres, are some of the numerous problems which may be solved with such data.

✦ ✦ ✦

TEN flue loss charts, for temperatures of 1200 to 2400°F,

(*Please turn to Page 698*)

Strength!

Clark Cable and Insulated Wire Spools provide strength and rigidity for the most difficult wire and solder winding operations.

This rugged construction is easy to assemble, reducing over-all costs of operation.

A simple hand arbor, foot or power press operation permanently assembles heads and barrels. All parts are lithographed for identification purposes and to protect the metal.

SPECIFICATIONS

HEAD DIAMETERS —5, 6½", and 10½"
BARREL DIAMETERS—1 5/16", and 3½" (special diameter for 10½" head)
BARREL LENGTHS —To meet your capacity needs

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NORTON ABRASIVES ?

for Shaping, Grinding and Polishing Wire Drawing Dies?

CRYSTOLON ABRASIVE — you'll like the fast cutting action of this hard, sharp silicon carbide abrasive — made in Norton Company's own electric furnace plant under carefully controlled conditions.

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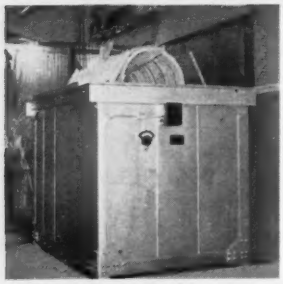
NORTON ABRASIVES



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HI - SPEED
ROD BAKER
Patents Pending

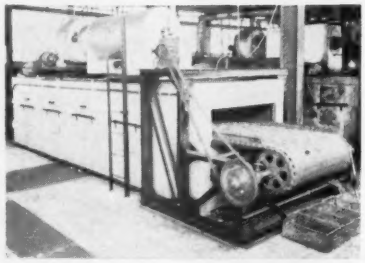
Results of first installation bring second order for Carl - Mayer HI-SPEED Indirect Pit Type Rod Baker from prominent Steel Company of Canada. Check these production figures:

Baker Temperature, 500°F. Load per Pin, 2100 lbs.

LOW CARBON, .15-.20			HI-CARBON, .4-.7		
7	Minutes	per pin	9	Minutes	per pin
7	"	"	10	"	"
6	"	"	11	"	"
8	"	"	10	"	"
6	"	"	9	"	"

PLUS 50% FUEL REDUCTION Write for complete data.

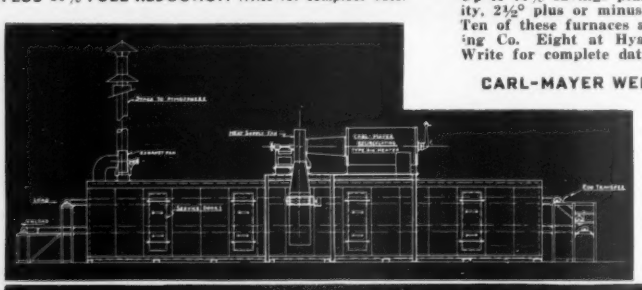
CARL-MAYER
FURNACES, ROD BAKERS
WELDING ROD OVENS



CARL-MAYER AIR DRAW FURNACE

Up to 70% savings plus temperature uniformity, 2½° plus or minus. Air heater principle. Ten of these furnaces at Timken Roller Bearing Co. Eight at Hyatt Roller Bearing Co. Write for complete data.

CARL-MAYER WELDING ROD OVEN



As built for the Page Steel & Wire Co. and Hallup Corp. for drying coated alloy welding rods, using the "Mayer" recirculating gas fired air heater principle. Write for complete data.

OVER 20 YEARS EXPERIENCE

The CARL-MAYER Corp.
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BELL-MINE ROTARY KILN PULVERIZED LIME

MANUFACTURED BY THE WARNER COMPANY (BELLEFONTE DIVISION) AT BELLEFONTE, PA. SALES OFFICES AT PITTSBURGH, NEW YORK CITY, PHILADELPHIA AND WILMINGTON

WARNER COMPANY
Lime
Bell Mine
Products
BELLEFONTE DIVISION

for wire drawing

Corrosion of Furnace Reducing Atmospheres

(*Continued from Page 692*)

are presented which show how the heat in flue products increases as air supplied for combustion is decreased from theoretically complete aeration to the lowest aeration supporting combustion. These charts cover three different fuel gases. Total heat in flue products, as well as heat due to the individual items, heat content of gases (sensible heat), latent heat of vaporization of uncondensed water, and potential heat of unburned combustibles, is presented in Btu per cubic foot of fuel gas burned for each aeration. In addition, a chart is included which expresses the total heat in flue products at various aerations on the basis of the percentage of that in the fuel burned. Still other charts are presented for those desiring flue loss data when only the CO_2 content of the flue gases and its temperature are known. These charts, together with others showing flue gas volumes, permit exact determination of cooling requirements for atmosphere treating purposes; and separately, provide information on thermal characteristics of a furnace.

✦ ✦ ✦

A CHAPTER entitled "Practical Interpretation of Data," discusses various uses of furnace atmospheres, points out how certain atmospheres of desired composition may be made from partially burned gases, demonstrates use of flue loss data for treated and untreated atmospheres, and presents significant suggestions on burner and combustion chamber design.

✦ ✦ ✦

OTHER information incorporated in the bulletin includes: effect of combustion chamber wall temperature on composition of flue products; effect of flue gas temperature on flue gas composition; CO/CO_2 ratios in flue products; CO/H_2 ratios in flue products; maximum flue gas temperatures developed by combustion at various aerations; combustion space required for various aerations; flame lengths for various conditions of

combustion; and suitable methods for accurate sampling, analyzing, and measuring the temperature of flue gases resulting from combustion under reducing conditions.

✦ ✦ ✦

The Worthington Multi-V-Drive Master Manual

POWER transmission through V-belts is presented in an exceptionally clear and interesting way in a "Master Manual" recently published by the Worthington Pump & Machinery Corporation of Harrison, New Jersey.

✦ ✦ ✦

WITHOUT formality or waste of space the Manual rolls up its sleeves on the inside front cover and states, "Select a Multi-V-Drive the Worthington way — in 3 minutes by the watch. No calculations—Just simple arithmetic. No engineering — Just Common Sense. No trick figuring — Just Plain ABC." And then the Manual tells in a clear and straightforward way precisely how it can be done by anybody who is able to do common arithmetic.

✦ ✦ ✦

THE Manual is also amply and interestingly illustrated. No special tools are required to quickly demount the rim—"Just a man and a wrench and 60 seconds"—and the job is done.

✦ ✦ ✦

THE Manual also makes clear by means of excellent diagrams why important drives should **never** be underbelted. For instance where five belts should be used, but the user decides to install only 4 belts, he reduces the life of the drive by 60 per cent. And, similarly, it does **not** pay to use pulleys that are too small, a 6″ pulley giving a belt life nearly 3 times as great as a 5″ pulley on the same drive. Nor does it pay to operate with a belt speed that is too high. The Manual shows and tells why.

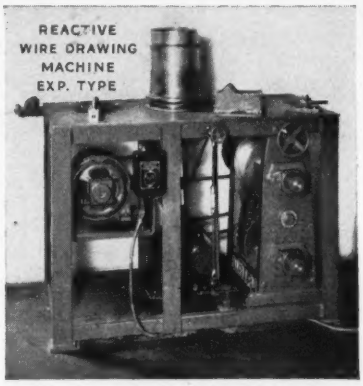
✦ ✦ ✦

AND so on throughout. There are 72 pages in all, and each page is packed with facts that every belt user should either know or have quickly available at his finger tips.

SINGLE HOLE AND CONTINUOUS PRODUCTION MACHINES

MORE WIRE and BETTER WIRE---At Less Cost

Less Power Per Ton — Lower Die Costs



More Production — Lower Costs Per Ton

(Manufactured and sold under Smith-Stringfellow Patents)

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AIMCO AUTOMATIC PANNING MACHINE

For Rubber Covered Wire Ball Bearing

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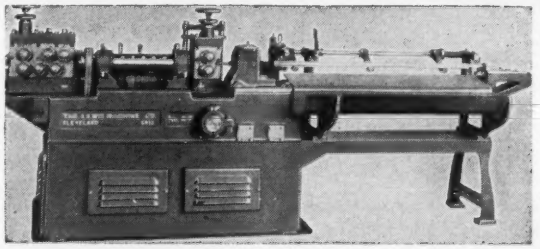
LEWIS TRAVEL-CUT WIRE STRAIGHTENING and CUTTING Machines



Machines for 1/16" to ¾" rod

Round

Square

Flat

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Ferrous and Non-Ferrous

Automatic

High Speed

Heavy Duty

The Sign of Dependable Service:

WE CAN SUPPLY AND ENGINEER OUR TOOLS EQUIPPED WITH CARBOLOY CEMENTED CARBIDE

THE LEWIS MACHINE CO., 3445 E. 76 St., Cleveland, Ohio

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Paralan will give your finished wire and wire products protection from atmospheric corrosion in the mill and in shipping. Paralan-coated wire can be spot welded or soldered without cleaning. Also, Paralan leaves surfaces in good condition for all types of finishes—enameling, japanning, lacquering, plating, etc.

Write for further information. We may be able to solve your difficulties.

AMERICAN LANOLIN CORP.
LAWRENCE, MASSACHUSETTS

STEELSKIN

REG. U. S. PAT. OFFICE

For High or Low Carbon Wire

WIRE DRAWING SOAPS

Established 30 years

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"STANDARD WIRE DRAW"

FOR HIGH-LOW CARBON, BRIGHT, COLD HEADING
WET WIRE DRAWING

- Lower die costs
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AKRON, OHIO

Manufacturers of Equipment for the Rubber, Wire, Wire Rope, Electric Cable, and Plastic Industries.

Improved Insulating Machinery for Western Electric Continuous Vulcanizing Process.

Plants: Akron, Ohio; Columbiana, Ohio; Clifton, N. J.

Main Office: Akron, Ohio
The Bawden Machine Co., Ltd., Toronto, Ont., Canada

David Bridge & Co., Ltd., Manchester, England

Roebling Announces New Pension Plan

ANOTHER proof that large, responsible industry is well aware of its social obligations was brought out by the announcement recently of a new, insured pension plan for eligible employees of the John A. Roebling's Sons Company of Trenton, New Jersey, and subsidiaries. The formal announcement was made by W. A. Anderson, president of the company.

✦ ✦ ✦

IN the past, the Roebling Company provided pensions under a self-administered plan begun in 1922. This plan is now being funded with the Equitable Life Assurance Society of the United States and, in addition, the company has adopted a group annuity program with respect to future service for employees earning more than $3,000 a year, this plan also being insured by the Equitable.

✦ ✦ ✦

THE company is paying the entire cost of pensions for service prior to July 1, when the new plan was made effective. These so-called "past-service" pensions will yield a monthly income at age 65 of one per cent of the employee's average monthly earnings over ten years preceding July 1, 1940, multiplied by the number of years of service rendered prior to that date, less one-half of the employee's monthly old-age benefit under the Social Security Act.

✦ ✦ ✦

WITH respect to the "future-service" pensions for employees earning more than $3,000 a year, the plan will provide additional retirement incomes above those to which the employees are eligible under the Social Security Act. Each employee will contribute five per cent of the excess of his annual earnings over $3,000 and the company will match his contributions dollar for dollar.

✦ ✦ ✦

THE Roebling family name has been a celebrated one in the field of suspension-bridge construction and cable for almost a century, the founder of the company, John A. Roebling, having been the builder of the Brooklyn

INCREASE LIFE OF YOUR DIES with *NEW* NOPCO SOAPS!

FOLLOW the lead of many of the country's largest steel wire mills. Increase the life of your dies by using Nopco "99" improved dry soaps.

In addition to longer life, you will find these 99% active dry soaps eliminate periodic die trouble formerly caused by faulty lubrication . . . result in a better wire finish . . . and give higher yields per pound of soap.

Nopco "99" soaps are available in three types—PX, LX and NX—for both high and low carbon wire and rod.

JUST ONE TRIAL WILL CONVINCE YOU!
Write Today!

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NATIONAL OIL PRODUCTS CO.
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ACID INHIBITOR

1. Stops Waste of Acid and Metal.
2. Prevents Over-Pickling.
3. Eliminates Acid Fumes.
4. Reduces Acid Brittleness.
5. Cuts Costs.
6. Increases Tonnage.

Ask for Bulletin.

American Chemical Paint Co.
Dept. 306, AMBLER, PENNA.
Detroit, Mich. Walkerville, Ont.

Bridge. From these early beginnings, the Roebling Company has become a large manufacturer of wire rope, electrical wires and cables, narrow-width strip steel, and a great variety of other types of special wire products.

✦ ✦ ✦

New Active Ingredient Makes Flextite Invaluable to the Plant Engineer

FLEXROCK'S Chief Chemist has developed a new active ingredient which, used in FLEXTITE, brings its activity down to a measure of seconds instead of minutes as in the case of other leak stopping materials. This new FLEXTITE is used with ordinary portland cement and forced against water pressure, held there only a few seconds and the leak is stopped.

✦ ✦ ✦

FLEXTITE is naturally invaluable in stopping leaks in dams, retaining walls, dykes, concrete holding water at irrigation plants, reservoirs, concrete tanks and other such places. It is also invaluable for water-proofing and damp proofing generally in cellars or basements, in pits, tanks, and other such places. Detailed instructions explaining the simplicity of handling this new, more active material may be obtained promptly by simply contacting **Flexrock Company,** 23d and Manning Sts., Philadelphia, Pa.

✦ ✦ ✦

Personnel Changes Announced By J & L

LAMAR J. VIEAU has been appointed assistant district sales manager, New York office, Jones & Laughlin Steel Corp., Pittsburgh. He formerly was general sales manager for McKeesport Tin Plate Corp., McKeesport, Pa. **Julius Graf,** formerly vice president, Treadwell Construction Co., New York, has been named assistant chief engineer for Jones & Laughlin. **C. F. Seyler** has been made assistant chief engineer of plants.

This is an invitation for you to become a member of The Wire Association.
The Annual Dues are $10.00

STEEL REELS AND DRUMS
for
WIRE AND CABLE INDUSTRY
R.B. HAYWARD CO.
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More Tonnage per Pound!

You can get a much higher tonnage of steel wire per pound of lubricant, insure longer die life and maintain better finish, with

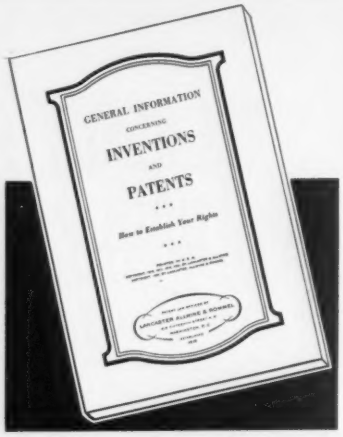
MAGNUS WIRE DRAWING COMPOUNDS

Specially formulated to meet the definite conditions of wire size, type of drawing operations and other factors you face in your mill. There's a Magnus lubricant to suit your problems exactly on both wet and dry drawing operations.

GET THIS PERFORMANCE DATA

Ask for your set of reports covering performance of Magnus Wire Drawing Lubricants on all kinds and types of wire.

MAGNUS CHEMICAL CO.
188 South Ave., Garwood, N. J.
MAGNUS CLEANERS



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Wire Drawing Diamond Dies

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WIRE DIE CORPORATION
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Tel. Col. 5-1340

Steel Quality

(*Continued from Page 681*)

at the same time successfully meet its competition, keep its plants and equipment up-to-date, and earn a reasonable return for the people who have invested their money in the company.

✦ ✦ ✦

THEY want to feel free to deal with their employers on questions of wages and hours, collectively or individually, as they may prefer.

✦ ✦ ✦

THEY want good working conditions, and a full measure of protection against accidents.

✦ ✦ ✦

THEY want to know what is going on, and why. I think this is very important. Take, for instance, the situation in which an obsolete mill is being replaced by modern equipment. **Why** is it being replaced? I think the management ought to give the men the facts. Once they realize that improvements are absolutely necessary to keep a plant in operation on a competitive basis, it may put an end to considerable misunderstanding.

✦ ✦ ✦

AND most important of all, I believe men want the assurance that they can get ahead. They want recognition for good work well done. Today especially it is a major part of the responsibility of management to know and to follow the individual records and accomplishments of every employee, in order that employees may be assured that individual skill and ability will in fact be given proper recognition, and that the people of this country may be assured that steel for national defense is being made by men of proven skill and ability.

✦ ✦ ✦

THE national defense program of the United States of America needs steel. It needs the best quality of steel that can possibly be produced. I can assure you right now—and believe me I am speaking from a knowledge of facts—that the steels which are needed will be ready; and the men who make these steels will do the job which is expected of them, and will do it 100 per cent. The men who make the steels that America needs can be counted on to do their job. You can rely upon them to do their utmost to defend our form of government and preserve the principles which form the foundation of our method of living in these United States.

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Skill and accuracy in manufacture with the use of selected stones make Balloffet Diamond Dies the choice of the most critical users.

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UNIVERSAL WIRE REEL

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Straightener Specialists Since 1866

Continuous Straightening and Cutting Machinery
With
FLYING SHEAR
for round and shaped wire.

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Wire Drawing Machinery

Featuring —
High Speed Upright Cone Machines.
Also —
Bull Blocks and Benches, Continuous Wire Drawing Machines, Spoolers, Pointers, String-up Machines, etc.
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Cold Heading Machinery.

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WATERPROOF
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CREPE PAPER
In rolls of any size for wrapping coils and reels.
CREPE-KRAFT BARREL LINERS
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APCO MOSSBERG CO.
the original Frank Mossberg Co.
Manufacturers of Reels and Spools
Attleboro, Mass.

New Drum Type Master Switch

A NEW drum type master switch providing 3-wire control for machine tools and other equipment is announced by **Cutler-Hammer, Inc.**, Milwaukee, Wisconsin, manufacturers of Motor Control and allied electrical equipment. This new type switch affords functions equivalent to two and three button heavy duty push button stations and is offered for use where an operating lever is preferred.

✦ ✦ ✦

THREE kinds of constructions are available—surface, cavity, and panel mounting — and two kinds of handles, standard and pistol grip (the illustration shows the various handle and mounting types). By removing a stop post, the drum may be converted from non-reversing to reversing.

✦ ✦ ✦

THE nameplate is marked on one side for reversing service and the other side for non-reversing service, thus making it suitable for either application.

✦ ✦ ✦

RATINGS of the new drum type master switch are for pilot circuits up to 600 volts A.C. and D.C.

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CONSULTANT
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SPRING MAKING
AND
WIRE WORKING
MACHINES & METHODS
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2—Baird No. 3 & S3F 4 Slide Wire Machines
7—Waterbury Step Cone Wire Drawing Machines
1—Two Spindle Bull Block Motor Driven
6—Lewis Welding Wire S & C Machines M. D.
2—Shuster Shaped Wire S & C Machines ½" & ⅞"
8—Shuster Round Wire S & C Machines 1/32"-½"
Wanted: Tack Making Machinery. All Sizes.

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Leading manufacturers of
OVERHEAD MATERIALS HANDLING EQUIPMENT
for the Wire and Wire Products Industry

WRAPPING MACHINES
Coil & Straight Length
TERKELSEN MACHINE CO.
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ZINC WIRE
ZINC STRIP
THE PLATT BROS. & CO.
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SPARKERS
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Rod Frames — 16" Frames, 8" Frames — Take-Up Frames, Wire Pointers — Puller Tongs.
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Circulars on Request.
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Wire Mill and Cold Rolling Equipment
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STEEL REELS AND SPOOLS

SPOOLS AND REELS
FOR THE WIRE INDUSTRY
Hubbard Spool Company
1622 Carroll Ave. Chicago, Ill.

We manufacture Electric Spot Welders from ¾ to 500 K.V.A. We also make standard and special Transformers of all kinds. A.C. Arc Welders from 100 to 400 Amps.
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"THE SHIFTWEIGHT"
TILTING WIRE REEL
One man loading reel = for wire coils up to 300 pounds.
MOSLO MACHINERY, INC.
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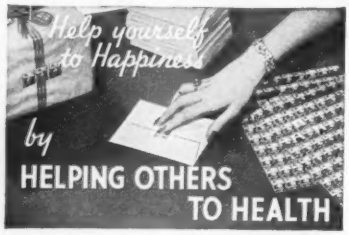
H. J. French and T. N. Armstrong Awarded Lincoln Medal

H. J. FRENCH and T. N. Armstrong, metallurgists of the Development and Research Division of The International Nickel Company, Inc., have been awarded the Lincoln Gold Medal for 1940 for their technical paper entitled "Weld Hardening of Carbon and Alloy Steels."

✦ ✦ ✦

THIS paper was originally presented on October 23, 1939, before the American Welding Society at the National Metal Congress in Chicago and subsequently appeared in the October, 1939, Welding Journal of the American Welding Society. The Lincoln Gold Medal is given each year to the author or authors contributing most to the development and advancement of welding.

✦ ✦ ✦



This Christmas—be a partner in a great life-saving campaign. Use plenty of Christmas Seals on your letters and packages. They are gay, colorful . . . and what's more important . . . they spread a message of Tuberculosis control and prevention that is vital to the good health of us all!
Since 1907, the annual sale of Christmas Seals has done its share in helping to reduce the death rate from Tuberculosis by 75%! Complete eradication is now in sight! But no one is safe from Tuberculosis until *everyone* is safe. So help yourself—by helping others!

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The National, State and Local Tuberculosis Associations in the United States

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WINDING AND SPECIAL MACHINES
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THOMSON-JUDD
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THOMSON-GIBB ELECTRIC WELDING COMPANY
LYNN, MASSACHUSETTS
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409 Mulberry St., Newark, N. J.

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For WIRE, RUBBER, TEXTILES, PAPER, Etc.
HENRY L. SCOTT CO.
PROVIDENCE, R. I.

TANKS
FOR EVERY MILL OPERATION
CLEANING—PICKLING—PLATING.
LEAD LINING RUBBER LINING
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CINCINNATI, OHIO

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WHERE TO BUY

For more complete information, consult the annual Wire and Wire Products Directory, Index & Buyers' Guide.

ABRASIVES—
Norton Co., Worcester, Mass.

AIR DRAW FURNACES—
Carl-Mayer Corp., The, Cleveland, Ohio.

ANNEALING MACHINES—Open Flame
Drever, Co., The, Philadelphia, Pa.
Syncro Machine Co., Rahway, N. J.

ANNEALING POTS AND BOXES—
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.

ANTI-RUST—Compound
Magnus Chemical Co., Garwood, N. J.
National Oil Products Co., Harrison, N. J.

ARMORING EQUIPMENT—
American Insulating Mach'y. Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Watson Machine Co., Paterson, N. J.

AUTOMATIC SPARK TESTING EQUIPMENT—
Entwistle, James L., Pawtucket, R. I.

BAKERS—Hi-Speed
Carl-Mayer Corp., The, Cleveland, Ohio.

BAKERS—Rod and Wire
Carl-Mayer Corp., The, Cleveland, O.
Morgan Construction Co., Worcester, Mass.
Moslo Machinery, Inc., Cleveland, O.
Ross, J. O., Engineering Corp., New York, N. Y.

BERYLLIUM COPPER—Strip and Bars
Callite Tungsten Corp., Union City, N. J.

BOBBINS—Braider and Wire Weaving
Apco Mossberg Co., Attleboro, Mass.
Clark, J. L., Mfg. Co., Rockford, Ill.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.

BORON CARBIDE—
Norton Co., Worcester, Mass.

CARRIERS—Braider, High Speed
Apco Mossberg Co., Attleboro, Mass.
Mossberg Pressed Steel Corp., Attleboro, Mass.

CEMENT FLOOR CLEANER—
Magnus Chemical Co., Garwood, N. J.

CEMENTS—Refractory
Norton Co., Worcester, Mass.

CHEMICALS—Cleaning
American Chemical Paint Co., Ambler, Pa.
Magnus Chemical Co., Garwood, N. J.
Standard Industrial Compounds Co., Chicago, Ill.

CLEANERS—Hand and Metal
Magnus Chemical Co., Garwood, N. J.
Standard Industrial Compounds Co., Chicago, Ill.

CLEANING & PICKLING EQUIPMENT—
Broden Construction Co., Cleveland, O.
Cleveland Tramrail Div. of the Cleveland Crane & Engineering Co., Wickliffe, Ohio.
Hauser-Stander Tank Co., Cincinnati, O.
Lee Wilson Engineering Co., Cleveland, Ohio
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

CLOTH TESTERS—
Scott, Henry L., Co., Providence, R. I.

CLOTH—Wire, All Metals
Callite Tungsten Corp., Union City, N. J.

COATING—Protective
American Lanolin Corp., Lawrence, Mass.
National Oil Products Co., Harrison, N. J.

WHERE TO BUY, Continued

COILERS—Sheet, Strip and Wire
Broden Construction Co., Cleveland, O.
Ruesch, H. J., Machine Co., Newark, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

COILERS AND SPOOLERS FOR INSULATED WIRES—
Entwistle, James L., Pawtucket, R. I.

COMPOUNDS—Wire Drawing
Magnus Chemical Co., Garwood, N. J.
National Oil Products Co., Harrison, N. J.
Standard Industrial Compounds Co., Chicago, Ill.

COPHOLDERS—Steel
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.

COPPER—Electrolytic
Scomet Engineering Co., New York, N. Y.

CRANES—Wire Mill
American Monorail Co., Cleveland, O.
Cleveland Tramrail Div. of Cleveland Crane & Engineering Co., Wickliffe, O.
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

CUTTING TOOLS—Carbide
Carboloy Co., Inc., Detroit, Mich.
Firth-Sterling Steel Co., McKeesport, Pa.
Vascoloy-Ramet Corp., North Chicago, Ill.

DIAMONDS—Industrial
Callite Tungsten Corp., Union City, N. J.

DIAMOND POWDERS—
Rusch Wire Die Corp., New York, N. Y.

DIAMOND TOOLS—
Rusch Wire Die Corp., New York, N. Y.

DIES—Diamond
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N. J.
Cochaud Wire Die Co., New York, N. Y.
Kelly Wire Die Corp., New York, N. Y.
Krause, F., & Co., Inc., Jersey City, N. J.
Rusch Wire Die Corp., New York, N. Y.
Vianney Wire Die Works, New York, N. Y.

DIES—Lead Extrusion
Robertson, John, Co., Brooklyn, N. Y.

DIES—Repairs & Re-Cutting
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N. J.
Carboloy Co., Inc., Detroit, Mich.
Cochaud Wire Die Co., New York, N. Y.
Firth-Sterling Steel Co., McKeesport, Pa.
Kelly Wire Die Corp., New York, N. Y.
Krause, F., & Co., Inc., Jersey City, N. J.
Rusch Wire Die Corp., New York, N. Y.
Vascoloy-Ramet Corp., North Chicago, Ill.
Vianney Wire Die Works, New York, N. Y.

DIES—Rod and Tube Drawing
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N. J.
Carboloy Co., Inc., Detroit, Mich.
Firth-Sterling Steel Co., McKeesport, Pa.
Kelly Wire Die Corp., New York, N. Y.
Rusch Wire Die Corp., New York, N. Y.
Tungsten Electric Corp., Union City, N. J.
Vascoloy-Ramet Corp., North Chicago, Ill.
Vianney Wire Die Works, New York, N. Y.

DIES—Tantalum Carbide
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N. J.
Carboloy Co., Inc., Detroit, Mich.
Firth-Sterling Steel Co., McKeesport, Pa.
Kelly Wire Die Corp., New York, N. Y.
Rusch Wire Die Corp., New York, N. Y.
Vascoloy-Ramet Corp., North Chicago, Ill.
Vianney Wire Die Works, New York, N. Y.

DIES—Tungsten Carbide
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N. J.
Carboloy Co., Inc., Detroit, Mich.
Firth-Sterling Steel Co., McKeesport, Pa.
Kelly Wire Die Corp., New York, N. Y.
Rusch Wire Die Corp., New York, N. Y.
Tungsten Electric Corp., Union City, N. J.
Vascoloy-Ramet Corp., North Chicago, Ill.
Vianney Wire Die Works, New York, N. Y.

DRAW BENCHES—
Ruesch, H. J., Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
Standard Machinery Co., Providence, R. I.
Vaughn Machinery Co., Cuyahoga Falls, O

DRUMS—Flange Steel
Stevens Metal Products Co., Niles, O.

DRUMS—Vulcanizing
Mossberg Pressed Steel Corp., Attleboro, Mass.

ENGINEERS—Consulting Wire Mill
Hartley, George D., Worcester, Mass.
Lewis, Kenneth B., Worcester, Mass.

EQUIPMENT—Insulation Testing
Davis, R. L., Electric Co., Wallingford, Conn.
Entwistle, James L., Pawtucket, R. I.

EYELETS—Brass or Zinc
Platt Bros. & Co., The, Waterbury, Conn.

FURNACES—Annealing
Carl-Mayer Corp., The, Cleveland, O.
Drever Co., The, Philadelphia, Pa.
Electric Furnace Co., Salem, O.
Lee Wilson Engineering Co., Cleveland, Ohio
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Automatic
Carl-Mayer Corp., The, Cleveland, Ohio.
Electric Furnace Co., Salem, O.
Lee Wilson Engineering Co., Cleveland, Ohio
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Brazing
Electric Furnace Co., Salem, O.
Firth-Sterling Steel Co., McKeesport, Pa.

FURNACES—Bright Annealing
Electric Furnace Co., Salem, O.
Lee Wilson Engineering Co., Cleveland, Ohio
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Electric
Electric Furnace Co., Salem, O.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Hardening and Tempering
Carl Mayer Corp., The, Cleveland, Ohio.
Electric Furnace Co., Salem, O.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Lead Melting
Electric Furnace Co., Salem, O.
Robertson, John, Co., Brooklyn, N. Y.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Non-Oxidizing
Carl-Mayer Corp., The, Cleveland, Ohio.
Electric Furnace Co., Salem, O.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Normalizing
Carl-Mayer Corp., The, Cleveland, Ohio.
Electric Furnace Co., Salem, O.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Salt Bath
Electric Furnace Co., Salem, O.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Wire, Strip & Sheet
Carl-Mayer Corp., The, Cleveland, Ohio.
Electric Furnace Co., Salem, O.
Lee Wilson Engineering Co., Cleveland, O.
Surface Combustion Corp., Toledo, Ohio.

GALVANIZING EQUIPMENT—
Lee Wilson Engineering Co., Cleveland, Ohio

GRINDERS—ROLL
Norton Co., Worcester, Mass.

HI-SPEED BAKERS—
Carl-Mayer Corp., The, Cleveland, Ohio.

HOISTS—Electric Traveling
American Monorail Co., Cleveland, O.
Cleveland Tramrail Div. of the Cleveland Crane & Engineering Co., Wickliffe, Ohio.

INHIBITORS—
American Chemical Paint Co., Ambler, Pa.
National Oil Products Co., Harrison, N. J.

INSTRUMENTS—Electrical
Entwistle, James L., Pawtucket, R. I.

LATHES—Die Reaming
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

LIME—
Warner Co., The, Bellefonte, Pa.

LUBRICANTS—For Metal Cutting, Stamping and Drawing
Magnus Chemical Co., Garwood, N. J.
Miller, R. H., Co., Homer, N. Y.
National Oil Products Co., Harrison, N. J.
Standard Industrial Compounds Co., Chicago, Ill.

LUBRICANTS—Wire Drawing
Magnus Chemical Co., Garwood, N. J.
Miller, R. H., Co., Homer, N. Y.
National Oil Products Co., Harrison, N. J.
Standard Industrial Compounds Co., Chicago, Ill.

MACHINERY—Armoring (Cable, Wire Hose)
American Insulating Mach'y. Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Robertson, John, Co., Brooklyn, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Thomson-Judd Wire Machinery Co., Sub. of Thomson-Gibb Electric Welding Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Braiding
Fidelity Machine Co., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Watson Machine Co., Paterson, N. J.

MACHINERY—Brazing
Thomson-Judd Wire Machinery Co., Sub. of Thomson-Gibb Electric Welding Co., Lynn, Mass.

MACHINERY—Bunching
American Insulating Mach'y. Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Bundling, Scrap
Sleeper & Hartley, Inc., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.
Watson Machine Co., Paterson, N. J.

MACHINERY—Cable, Electric
American Insulating Mach'y. Co., Phila., Pa.
Entwistle, James L., Pawtucket, R. I.
Fidelity Machine Co., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Syncro Machine Co., Rahway, N. J.
Thomson-Judd Wire Machinery Co., Sub. of Thomson-Gibb Electric Welding Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Chain Making
Nilson, A. H., Machine Co., The, Bridgeport, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Closing
New England Butt Co., Providence, R. I.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Coil Winding
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Coilers
Broden Construction Co., Cleveland, O.
Entwistle, James L., Pawtucket, R. I.
Morgan Construction Co., Worcester, Mass.
New England Butt Co., Providence, R. I.
Ruesch, H. J., Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Waterbury-Farrel Fdry. & Machine Co., Waterbury, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Copper Wire Drawing and Rolling
Ruesch, H. J., Machine Co., Newark, N. J.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Fdry. & Machine Co., Waterbury, Conn.

MACHINERY—Covering Wire
Fidelity Machine Co., Philadelphia, Pa.
Syncro Machine Co., Rahway, N. J.

MACHINERY—Cutting
Broden Construction Co., Cleveland, O.
Hallden Machine Co., Thomaston, Conn.
Lewis Machine Co., The, Cleveland, O.
Moslo Machinery Inc., Cleveland, O.
National Machinery Exchange (Used), New York, N. Y.
Nilson, A. H., Machine Co., The, Bridgeport, Conn.
Shuster, F. B., Co., New Haven, Conn.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.

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MACHINERY—Die Making
Firth-Sterling Steel Co., McKeesport, Pa.

MACHINERY—Draw Benches
Standard Machinery Co., Providence, R. I.

MACHINERY—Edging
Standard Machinery Co., Providence, R. I.

MACHINERY—Enameling
American Insulating Mach'y. Co., Phila., Pa.
Syncro Machine Co., Rahway, N. J.

MACHINERY—Extruding
Robertson, John, Co., Brooklyn, N. Y.
Royle, John & Sons, Paterson, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Flat Wire
Broden Construction Co., Cleveland, O.
Ruesch, H. J., Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Forming
National Machinery Exchange (Used), New York, N. Y.
Nilson, A. H., Machine Co., The, Bridgeport, Conn.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Machinery Co., Providence, R. I.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Galvanizing
Lee Wilson Engineering Co., Cleveland, Ohio

MACHINERY—Galvanizing Wire
Broden Construction Co., Cleveland, O.
Lee Wilson Engineering Co., Cleveland, Ohio
Sleeper & Hartley, Inc., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Gang Winders
Fidelity Machine Co., Philadelphia, Pa.
Ruesch, H. J., Machine Co., Newark, N. J.
Syncro Machine Co., Rahway, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Grinding
Norton Co., Worcester, Mass.

MACHINERY—Insulating
American Insulating Mach'y. Co., Phila., Pa.
Fidelity Machine Co., Philadelphia, Pa.
National Rubber Machinery Co., Akron, O.
New England Butt Co., Providence, R. I.
Royle, John & Sons, Paterson, N. J.
Syncro Machine Co., Rahway, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Knitting
Fidelity Machine Co., Philadelphia, Pa.

MACHINERY—Lead Encasing
Robertson, John, Co., Brooklyn, N. Y.

MACHINERY—Lead Stripping
Robertson, John, Co., Brooklyn, N. Y.
Watson Machine Co., Paterson, N. J.

MACHINERY—Lock Washer
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., Torrington, Conn.

MACHINERY—Magnet Wire
American Insulating Mach'y. Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Material Handling
American Monorail Co., Cleveland, O.
Cleveland Tramrail Div. of the Cleveland Crane & Engineering Co., Wickliffe, Ohio.

MACHINERY — Measuring Wire & Cable
Davis, R. L., Electric Co., Wallingford, Conn.
New England Butt Co., Providence, R. I.
Watson Machine Co., Paterson, N. J.

MACHINERY—Nail and Tack
Glader, Wm., Machine Works Co., Chicago, Ill.
National Machinery Exchange (Used), New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Panning
American Insulating Mach'y. Co., Phila., Pa.
Syncro Machine Co., Rahway, N. J.

MACHINERY—Paper Covering Wire
Terkelsen Machine Co., Boston, Mass.

MACHINERY—Pointing
Broden Construction Co., Cleveland, O.
Ruesch, H. J., Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Machinery Co., Providence, R. I.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Fdry. & Machine Co., Waterbury, Conn.

MACHINERY—Rod Mill
Broden Construction Co., Cleveland, O.
Morgan Construction Co., Worcester, Mass.
Ruesch, H. J., Machine Co., Newark, N. J.

MACHINERY—Rolling Mill
Broden Construction Co., Cleveland, O.
Morgan Construction Co., Worcester, Mass.
National Machinery Exchange (Used), New York, N. Y.
Ruesch, H. J., Machine Co., Newark, N. J.
Standard Machinery Co., Providence, R. I.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Waterbury-Farrel Fdry. & Machine Co., Waterbury, Conn.

MACHINERY—Rubber for Insulating Wire
National Rubber Machinery Co., Akron, O.
Royle, John & Sons, Paterson, N. J.

MACHINERY—Rubber Strip Covering
National Rubber Machinery Co., Akron, O.
New England Butt Co., Providence, R. I.
Watson Machine Co., Paterson, N. J.

MACHINERY—Rubber Tubing and Straining
National Rubber Machinery Co., Akron, O.
New England Butt Co., Providence, R. I.
Royle, John & Sons, Paterson, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Screw Wire
National Machinery Exchange (Used), New York, N. Y.
Sleeper & Hartley, Worcester, Mass.

MACHINERY—Special
American Insulating Mach'y. Co., Phila., Pa.
Broden Construction Co., Cleveland, O.
National Rubber Machinery Co., Akron, O.
New England Butt Co., Providence, R. I.
Ruesch, H. J., Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Machinery Co., Providence, R. I. (Special Designs)
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Spooling
American Insulating Mach'y. Co., Phila., Pa.
Fidelity Machine Co., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Fdry. & Machine Co., Waterbury, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Spring Making
National Machinery Exchange (Used), New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Staple
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Straightening
Broden Construction Co., Cleveland, O.
Hallden Machine Co., Thomaston, Conn.
Lewis Machine Co., The, Cleveland, O.
Moslo Machinery, Inc., Cleveland, O.
National Machinery Exchange (Used), New York, N. Y.
Nilson, A. H., Machine Co., The, Bridgeport, Conn.
Ruesch, H. J., Machine Co., Newark, N. J.
Shuster, F. B., Co., New Haven, Conn.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn

MACHINERY—Stranding
National Rubber Machinery Co., Akron, O.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Thomson-Judd Wire Machinery Co., Sub. of Thomson-Gibb Electric Welding Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Strip Steel
Broden Construction Co., Cleveland, O.
Ruesch, H. J., Machine Co., Newark, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Swaging
National Machinery Exchange (Used), New York, N. Y.
Ruesch, H. J., Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Machinery Co., Providence, R. I.
Syncro Machine Co., Rahway, N. J.
Waterbury-Farrel Fdry. & Machine Co., Waterbury, Conn.

MACHINERY—Taping
American Insulating Mach'y. Co., Phila., Pa.
Fidelity Machine Co., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Syncro Machine Co., Rahway, N. J.
Thomson-Judd Wire Machinery Co., Sub. of Thomson-Gibb Electric Welding Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Testing
Entwistle, James L., Pawtucket, R. I.
Scott, Henry L., Co., Providence, R. I.

MACHINERY—Testing Size of Wire
Davis, R. L., Electric Co., Wallingford, Conn.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Testing—Spring
Standard Machinery Co., Providence, R. I.

MACHINERY—Tinsel Rolling Mills
American Insulating Mach'y. Co., Phila., Pa.
Syncro Machine Co., Rahway, N. J.

MACHINERY—Trolley Wire
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Tube Mill
Ruesch, H. J., Machine Co., Newark, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Welding Wire
Eisler Engineering Co., Inc., Newark, N. J.
Igoe Bros., Inc., Newark, N. J.
Micro Products Co., Chicago, Ill.
Shuster, F. B., Co., New Haven, Conn.
Thomson-Judd Wire Machinery Co., Sub. of Thomson-Gibb Electric Welding Co., Lynn, Mass.

MACHINERY—Winding
American Insulating Mach'y. Co., Phila., Pa.
Entwistle, James L., Pawtucket, R. I.
Fidelity Machine Co., Philadelphia, Pa.
New England Butt, Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Wire Drawing
American Insulating Mach'y. Co., Phila., Pa.
Broden Construction Co., Cleveland, O.
Morgan Construction Co., Worcester, Mass.
National Machinery Exchange (Used), New York, N. Y.
Reactive Wire Drawing, Worcester, Mass.
Ruesch, H. J., Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Machinery Co., Providence, R. I.
Syncro Machine Co., Rahway, N. J.
Thomson-Judd Wire Machinery Co., Sub. of Thomson-Gibb Electric Welding Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Fdry. & Machine Co., Waterbury, Conn.

MACHINERY—Wire Measuring
Watson Machine Co., Paterson, N. J.

MACHINERY—Wire Rope
National Rubber Machinery Co., Akron, O.
New England Butt Co., Providence, R. I.
Thomson-Judd Wire Machinery Co., Sub. of Thomson-Gibb Electric Welding Co., Lynn, Mass.
Watson Machine Co., Paterson, N. J.

MACHINERY—Wire Tinning
American Insulating Mach'y. Co., Phila., Pa.
New England Butt, Co., Providence, R. I.
Syncro Machine Co., Rahway, N. J.

MACHINERY—Wood Screw
National Machinery Exchange (Used), New York, N. Y.

MATERIAL HANDLING EQUIPMENT—
American Monorail Co., Cleveland, O.
Cleveland Tramrail Div. of the Cleveland Crane & Engineering Co., Wickliffe, Ohio.

MILLS—Tandem Rolling and Edging
Standard Machinery Co., Providence, R. I.
Torrington Mfg. Co., The, Torrington, Conn.

NICKEL SILVER AND PHOSPHOR BRONZE—Rod, Wire and Strip
Hudson Wire Co., Ossining, N. Y.

WHERE TO BUY, Continued

OILS—Wire Drawing
National Oil Products Co., Harrison, N. J.
Standard Industrial Compounds Co., Chicago, Ill.

OVENS—Industrial
Carl-Mayer Corp., Cleveland, Ohio.
Ross, J. O., Engineering Corp., New York, N. Y.

PANS—Vulcanizing
Mossberg Pressed Steel Corp., Attleboro, Mass.

PAPER—Creped Wrapping
Crepe-Kraft Co., Inc., Newark, N. J.

PAPER TESTERS—
Scott, Henry L., Co., Providence, R. I.

PATENT ATTORNEYS—
Lancaster, Allwine and Rommel, Washington, D. C.

PICKLING COMPOUNDS
American Chemical Paint Co., Ambler, Pa.
National Oil Products Co., Harrison, N. J.

PLASTIC TESTERS—
Scott, Henry L., Co., Providence, R. I.

POTS—Lead Melting
Robertson, John, Co., Brooklyn, N. Y.

PRESSES—Hydraulic and Mechanical
Robertson, John, Co., Brooklyn, N. Y.
Standard Machinery Co., Providence, R. I. (Mechanical Only)

PRESSES—Lead
Robertson, John, Co., Brooklyn, N. Y.

PULLERS—Wire
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.

PUMPS—Hydraulic
Robertson, John, Co., Brooklyn, N. Y.

REACTIVE WIRE DRAWING
Reactive Wire Drawing, Worcester, Mass.

RECORDERS—Fault and Reel
Entwistle, James L., Pawtucket, R. I.

REEL AND TENSION STAND—
Fidelity Machine Co., Philadelphia, Pa.
Moslo Machinery, Inc., Cleveland, O.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

REEL CRUTCHES—
Watson Machine Co., Paterson, N. J.

REELS—Annealing and Stranding
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Co., Chicago, Ill.
Moslo Machinery, Inc., Cleveland, O.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Shuster, F. B., Co., New Haven, Conn.
Stevens Metal Products Co., Niles, O.

REELS—Steel
Apco Mossberg Co., Attleboro, Mass.
Hayward, R. B., Co., Chicago, Ill.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, O.

REELS AND SPOOLS—Shipping and Shop
Apco Mossberg Co., Attleboro, Mass.
Clark, J. L., Mfg. Co., Rockford, Ill.
Hayward, R. B., Co., Chicago, Ill.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, O.

REELS—Takeoff
Apco Mossberg Co., Attleboro, Mass.
Hayward, R. B., Co., Chicago, Ill.
Hubbard Spool Co., Chicago, Ill.
Moslo Machinery Inc., Cleveland, O.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Shuster, F. B. Co., New Haven, Conn.
Stevens Metal Products Co., Niles, O.

REELS—Vulcanizing and Impregnating
Apco Mossberg Co., Attleboro, Mass.
Hayward, R. B., Co., Chicago, Ill.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Shuster, F. B., Co., New Haven, Conn.
Stevens Metal Products, Co., Niles, O.

REELS—Wire Drawing
Apco Mossberg Co., Attleboro, Mass.
Clark, J. L., Mfg. Co., Rockford, Ill.
Hayward, R. B., Co., Chicago, Ill.
Hubbard Spool Co., Chicago, Ill.
Moslo Machinery, Inc., Cleveland, O.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products, Co., Niles, O.

REFRACTORIES—High Temperature
Norton Co., Worcester, Mass.

ROD BAKERS
Carl-Mayer Corp., The, Cleveland, O.
Moslo Machinery, Inc., Cleveland, O.
Ross, J. O., Engineering Corp., New York, N. Y.

RODS—Wire—Non-Ferrous
Hudson Wire Co., Ossining, N. Y.
Platt Bros. & Co., The, Waterbury, Conn.

RODS—Wire—Steel
Bethlehem Steel Co., Bethlehem, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.

ROLL STRAIGHTENERS—
Moslo Machinery, Inc., Cleveland, O.

RUBBER AND RUBBER COMPRESSION TESTERS—
Scott, Henry L., Co., Providence, R. I.

RUST PROOF COMPOUND—
American Lanolin Co., Lawrence, Mass.

SKIN PROTECTOR—
Magnus Chemical Co., Garwood, N. J.

SOAPS—Industrial and Wire Drawing
Magnus Chemical Co., Garwood, N. J.
Miller, R. H., Co., Homer, N. Y.
National Oil Products Co., Harrison, N. J.
Standard Industrial Compounds Co., Chicago, Ill.

SPARK TESTING EQUIPMENT—
Entwistle, James L., Pawtucket, R. I.

SPOOLS—Annealing and Wire Drawing
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Chicago, Ill.

SPOOLS—Shipping and Shop
Apco Mossberg Co., Attleboro, Mass.
Clark, J. L., Mfg. Co., Rockford, Ill.
Hayward, R. B., Co., Chicago, Ill.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, O.

SPOOLS—Steel
Apco Mossberg Co., Attleboro, Mass.
Clark, J. L., Mfg. Co., Rockford, Ill.
Hayward, R. B., Co., Chicago, Ill.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, O.

STAMPINGS—Steel
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.

STRIP—Brass and Non Ferrous
Hudson Wire Co., Ossining, N. Y.

STRIP—Steel
Bethlehem Steel Corp., Bethlehem, Pa.
Firth-Sterling Steel Co., McKeesport, Pa.
Pittsburgh Steel Co., Pittsburgh, Pa.

STRIP METAL TESTERS—
Scott, Henry L., Co., Providence, R. I.

SWIFTS—Take-off
Apco Mossberg Co., Attleboro, Mass.
Mossberg Pressed Steel Corp., Attleboro, Mass.

TAKE-UPS FOR CABLE, HOSE, LEAD PRESSES AND SHEET RUBBER—
Entwistle, James L., Pawtucket, R. I.

TANKS—Acid
Hauser-Stander Tank Co., Cincinnati, O.

TANKS—Compound
Watson Machine Co., Paterson, N. J.

TANKS—Lead Lined
Hauser-Stander Tank Co., Cincinnati, O.

TANKS—Pickling
Hauser-Stander Tank Co., Cincinnati, O.

TANKS—Rubber Lined
Hauser-Stander Tank Co., Cincinnati, O.

TANKS—Steel
Mossberg Pressed Steel Corp., Attleboro, Mass.

TANKS—Wooden
Hauser-Stander Tank Co., Cincinnati, O.

TENSILE TESTERS—
Scott, Henry L., Co., Providence, R. I.

TESTING INSTRUMENTS—
Entwistle, James L., Pawtucket, R. I.
Scott, Henry L., Co., Providence, R. I.

TRAMRAIL SYSTEMS—
Cleveland Tramrail Div. of the Cleveland Crane & Engineering Co., Wickliffe, Ohio.

TREADS—Safety
Norton Co., Worcester, Mass.

TRUCKS—
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

TUBE BENDERS AND FORMERS—
Ruesch, H. J., Machine Co., Newark, N. J.

TURKS HEADS—Friction and Power Driven
Standard Machinery Co., Providence, R. I.

VULCANIZERS—
Watson Machine Co., Paterson, N. J.

VULCANIZING PANS—
American Insulating Mach'y. Co., Phila., Pa.
Mossberg Pressed Steel Corp., Attleboro, Mass.

WELDERS—Spot and Butt
Eisler Engineering Co., Newark, N. J.
Igoe Bros., Inc., Newark, N. J.
Micro Products Co., Chicago, Ill.
Moslo Machinery, Inc., Cleveland, O.

WIRE—Cold Heading
Bethlehem Steel Co., Bethlehem, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.

WIRE—Electric
Hudson Wire Co., Ossining, N. Y.

WIRE—Enameled For Coils
Winsted Div. of Hudson Wire Co., Winsted, Conn.

WIRE—Manufacturers
Bethlehem Steel Co., Bethlehem, Pa.
Firth-Sterling Steel Co., McKeesport, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.

WIRE—Nickel Silver and Phosphor Bronze
Callite Tungsten Corp., Union City, N. J.
Hudson Wire Co., Ossining, N. Y.

WIRE—Non Ferrous to Specification For Special Purposes
Callite Tungsten Corp., Union City, N. J.
Hudson Wire Co., Ossining, N. Y.
Winsted Div. of Hudson Wire Co., Winsted, Conn.

WIRE—Spring
Bethlehem Steel Co., Bethlehem, Pa.
Firth-Sterling Steel Co., McKeesport, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.

WIRE—Stainless Steel
Callite Tungsten Corp., Union City, N. J.
Firth-Sterling Steel Co., McKeesport, Pa.

WIRE—Steel—Also Coppered Steel——Also Galvanized Steel
Bethlehem Steel Co., Bethlehem, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.

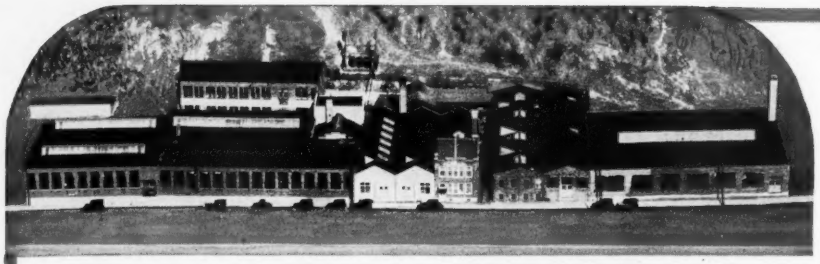
WIRE AND STRIP—Zinc
Platt Bros. & Co., The, Waterbury, Conn.

WIRE TESTERS—
Scott, Henry L., Co., Providence, R. I.

WIRE, WEAVING—Non Ferrous
Hudson Wire Co., Ossining, N. Y.

WRAPPING PAPER—Creped
Crepe-Kraft Co., Inc., Newark, N. J.

YARN TESTERS—
Scott, Henry L., Co., Providence, R. I.



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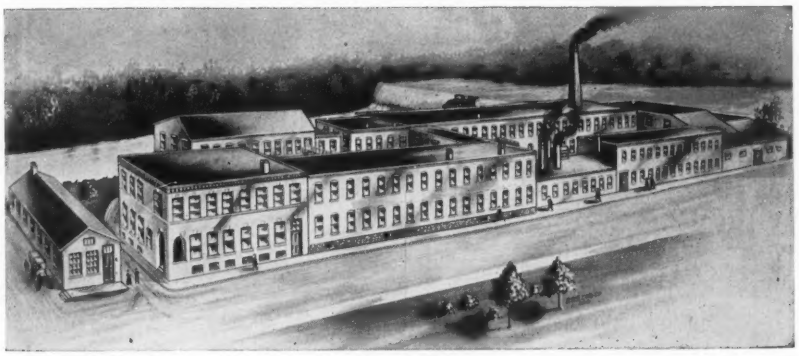

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High Brass, Low Brass, Zinc 99.99+ and High Tensile Zinc, Commercial Bronze, Phosphor Bronze, Pure Tin, Lead, Antimonial Lead, Tinsel Lahns, Silver Plated Copper, False Gold and Copper.

Cadmium, Nickel Silver, 10%, 18% and 30%; Silver Plated Copper, False Gold and Special Brass and Bronze Alloys to Specification, Metallic Fibre for Packing Purposes, Copper, Bronze, Zinc, Lead and Aluminum.

WIRES FOR METAL SPRAYING

Pure Lead, Lead Alloy, Pure Zinc, Zinc Alloy, Copper, Tin, High Brass, Low Brass, Solder Wire, High Conductivity, Electric Wire.

Cadmium, Nickel Silver, (10%, 18%, 30%); Aluminum, Monel Metal, Phosphor Bronze, Pure Nickel, Commercial Bronze.

"HUDCO" specially processed Copper Wire for enamelling purposes is drawn from Selected Copper, insuring the maximum conductivity. This is but one example of the use of the most advanced and approved materials and methods in our processing. BETTER WIRE AT LOWER COST.

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LEAKPROOF ENAMELLED WIRES

Drawn from special oxygen-free copper that works so clean, so free from slivers, that enamelling is perfect. Leaks positively prevented. Every foot of WINCO enamelled wire is mercury tested before shipment to assure a wire perfect in every particular.

WINCO enamelled wire is covered to the same dimensions as fabric-covered wire so the user need not change his equipment. It will withstand softening in varnish-dipping and baking.

WINCO enamelled wire is lower in cost than silk covered wire. Write for sample.

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